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TRANSACTIONS

AND

PROCEEDINGS

OF THE

Royal Society of Victoria.

JANUARY, 1865, TO JUNE, 1866.

VOL. VII.

Edited under the Authority of the Council of the Society.

BY

THE HONORARY SECRETARY, THOS. H. RAWLINGS, ESQ.

THE AUTHORS OF THE SEVERAL PAPERS ARE SOLELY RESPONSIBLE FOR THE SOUNDNESS OF THE OPINIONS GIVEN AND OF THE ACCURACY OF THE STATEMENTS MADE THEREIN.

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AGENTS TO THE SOCIETY.

WILLIAMS AND NORGATE, 14, HENRIETTA STREET, COVENT GARDEN, LONDON.

To whom communications for transmission to the Royal Society of Victoria from all parts of Europe should be sent.

10. Nov. 1920

PREFACE.

THE Seventh Volume of the "Transactions of the Royal Society of Victoria," now issued to the Members, brings the Proceedings of the Society to the close of the first six months of 1866.

It also embraces the Address of the President for this year, delivered on the 2nd July.

It will be seen that many of the papers are of considerable importance, both in their value as contributions to the literature of science, and also from their relation to a young colony, of which so much has yet to be learned.

The Council for the present year earnestly desire to continue the publication of the Transactions, by the issue of quarterly parts; but such a proceeding, involving as it does a large expenditure of money, together with a considerable amount of labour, can only be accomplished by the co-operation of the body of members. If those entrusted with the government of the Royal Society obtain that assistance, there is no reason to fear that the Papers will ever fall into the arrear from which they are now brought by the publication of the present volume.

ROYAL SOCIETY OF VICTORIA,

Melbourne, 30*th September*, 1866.

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FOR THE YEAR 1865.

Royal Society of Victoria.

1865.

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* Mr. James Bonwick was elected 12th June, 1865, on the resignation of Mr. Thomas Reed.

Royal Society of Victoria.

ANNIVERSARY ADDRESS

OF

The President,

THE REV. J. J. BLEASDALE D.D.

[Delivered to the Members of the Royal Society, at the Anniversary Meeting, held on the 4th May, 1865.]

GENTLEMEN,

It has ever been the custom of this Society for the President to deliver an address to the members at the commencement of his year of office. In taking my place this evening among you in the most honorable position to which you could raise me, the more honorable for the great men who have preceded me in it, I feel that many duties commensurate therewith have devolved upon me, and which I hope to be able to fulfil during this year, under the blessing of Providence, and with your earnest and generous co-operation.

Before entering upon a brief review of the labours of the Royal Society during the past year, and the advances made by science in the several departments whose objects we embrace, I will at the outset invite your attention for a moment to a subject which closely interests us all, viz., the present position and prospects of the Royal Society itself.

For this purpose it will be necessary to ask you to go back a few years, and recall the efforts which were then made by several of our officers and members, and, no doubt, with the best intentions, to swell the list of members, and give the Society all the appearance of a popular and flourishing institution. As a consequence numbers were induced to join, and were duly elected. Not a few of us at the time this was going forward pointed out that "numbers" were *not* strength in cases like our own. For while some joined with the main view of helping us with their subscriptions, and receiving copies of our Transactions as their only return, many many quite mistaking, or never having had experience of the working and nature of learned societies, were soon disappointed, and fell off in their attendance at our monthly meetings on account of the technical nature of the papers read, and the discussions on them, dry and uninteresting in proportion as they are learned, which necessarily fill up the greater portion of the time at our periodical meetings. At one time we *seemed* strong from the number of members, and the amount of entrance fees and subscriptions; but ere long it became evident, from the impossibility of rendering our meetings *popular*, as the phrase goes, that the attendance of our non-scientific friends was falling off. Had a record of attendance been kept, it would be at this day a curious and instructive document. Members of this class then became loath to renew their annual subscriptions, and with the falling off in numbers and money, came the cry that the Society itself was doomed. Writers followed writers in the public papers, seemingly to write us out of existence if possible. Latterly they have given it up, whether because they consider it a hopeless task to kill the Society out, or because they have discovered that there is real vitality in the body, now that its adventitious swathings and trappings have been torn off. At different times it has been said that we derived

a sort of vicarious life from one or other great name, which stood in our foremost rank, or from some happy accident, which, if removed, would cause the whole constitution to fade away into oblivion.

The labours of last year, to which I shall soon have to advert, will tell first how the Royal Society prospered under a great *scientific name*; how we got the measure of our real strength when we had come to know the full measure of our weakness; how we found our feet on firm ground, our knees strong, and our heads clear; how we made an estimate of our total strength; and then, gentlemen of the Society, how you dared to commit the destinies of this hopeful year to me and my colleagues in the Council. From the dislike which I always had of seeing men enter who had little or no fitness for helping in the work of such a body—and, may I say, from the gladness I felt in seeing them withdraw—I may, perhaps, be exposed to exaggerate when I congratulate you with all my heart on the present state of vitality in this our Royal Society. My reasons for this congratulation will be supplied by the matters which I have condensed, as much as in my power, into the paragraphs on which I must now enter.

At every one of the nineteen Ordinary Meetings we had read one or more papers, each and all of an interesting and useful character.

And perhaps the most striking of the many indications of real vitality may be found in the fact that I can announce that a new volume of our Transactions will soon be in your hands, which, for solid matter in a condensed form, is second to none which has preceded it: and which is a subject of congratulation in another sense, because it enables us to reciprocate our labours with the many cognate societies over the civilized world with which we correspond. I am also enabled to say that it will soon be followed by another

volume, which will bring our publications to date. Thenceforward it is in contemplation to publish our Transactions in pamphlet form, either monthly or quarterly, and complete a volume every year; thus placing before the public the every-day work of the Society, and affording the authors an opportunity of having the subjects they have treated thrown open to general discussion while still possessing their original freshness and interest. For several years past, with only the exception of the one just ended, this chair was filled by Sir Henry Barkly, our able Governor, of whose excellent management, and the ability he brought to bear on many of the most interesting of our papers and discussions, it may be out of place for me to descant. The Royal Society owes much to him.

On his resignation, Professor M'Coy, my immediate predecessor, was, I think, quite unanimously elected, and certainly the Society have to congratulate themselves on the results of the year, no less than on the *éclat* of his name and his *prestige* as a man of science.

Having premised thus much of our present condition, and a word or two of our future intentions, permit me now to lay before you a very brief outline of the subjects treated of and discussed during the by-gone year.

At the first Ordinary Meeting, held on the 16th May, a paper was read by W. H. Archer, Esq., Registrar-General, "On a Genus of Coleoptera, hitherto unknown in Victoria," of which large and beautiful specimens were exhibited.

This was followed by an exhaustive paper "On the Surface and Underground Drainage of Melbourne," by A. K. Smith, Esq., C.E. This valuable paper led to much discussion by the members, and as one evening was not sufficient for it, it was adjourned to our next meeting, with a direction that it should have precedence of all papers. In fact, this paper and the discussion upon it, led to an animated discus-

sion in the public papers, and it appears to have furnished the ideas for nearly all that has appeared in the public prints on that important subject ever since.

On the 6th June the adjourned discussion on the above paper took place, and entirely precluded any other scientific business. In the course of this night's discussion, Dr. Crooke set forth a suggestion for the drainage of the heavy floods of the Yarra, by cutting in directly at right angles to the river opposite Dight's mills, intercepting the tributary known as the Merri Creek, and conducting the storm and flood waters into Batman's Swamp, and so by the river into Hobson's Bay. This scheme, though not objected to on the score of fitness, was generally considered to involve too large an outlay in the construction of the channel.

On the 27th June the Secretary, R. L. J. Ellery, Esq., Astronomer to the Colony of Victoria, read a learned paper "On the Recent Determination of the Sun's Distance."

At the meeting on the 18th July, a valuable letter from Dr. Ferdinand Mueller was read, treating of the Poison Plant, so destructive to sheep (*gastrolobium grandiflorum*), from the neighbourhood of the Burdekin, Queensland.

At this meeting Wheatstone's Exploder and Abel's Patent Fuse were exhibited and explained by the Secretary.

8th August. At this meeting two very interesting papers were read, one by T. Harrison, Esq., entitled, "Notes on the Geology of Hobart Town," illustrated with maps and collections of fossils. At the close, Professor M'Coy described and named the fossils exhibited.

The other, "On the Yarra Floods and their Remedy," was by Robert Adams, Esq., and caused much interest, and the discussion was adjourned.

29th August opened with the discussion on Mr. Adam's paper, "Yarra Floods and their Remedy." This was followed by a learned paper from Professor Halford, "On the

Structure of Cartilage, as developed by the newly invented application of Magenta Dye," illustrated by microscopic specimens and diagrams. This able paper appears to clear up doubts which have long existed on the nature of the structure of cartilage, and the formation of bone, and, I venture to hope, it will be this year followed by others clearing disputed points in histology, and yielding many new and valuable articles on the diagnosis of diseased structures, and enlarging the sphere of the learned professor's usefulness far beyond the precincts of the University.

19th September. Professor M'Coy read an instructive paper "On an Australian Fish" (*genus arripis*), illustrated by preserved specimens and diagrams. Mr. Ellery at this meeting gave an account of Spectrum Analysis, as applied to Astronomy—a subject replete with curious interest, and concerning which I trust he will from time to time communicate his discoveries and results.

10th October. At this meeting I read a short paper, by permission (without notice), upon "The Desirability of holding an Exhibition of Colonial Gems, whether wrought or in their natural state; as also of Colonial Works in Jewellery, &c., &c."

On this occasion we received a Report from the Exploration Committee on the supposed discovery by Messrs. Giles and Conn of white men's graves near Cooper's Creek, which was brought up by Dr. Mueller. This was adopted, and a perfect copy sent to Mr. Augustus Gregory, Surveyor-General of Queensland, to obtain his opinion as to the utility of further investigation concerning Leichardt's fate.

31st October. There were three papers read at this meeting:—

1st. "Notes on the Tidal Phenomena of Hobson's Bay, with reference to the various suggested drainage schemes for the valley and basin of the River Yarra," was read by T. E.

Rawlinson, Esq., C.E., and listened to with much interest by the members.

2nd. The next was a paper entitled, "Notes on the Wealden Formation of England, as in some measure illustratrated by the Physical Features of Port Phillip Bay," by Thomas Harrison, Esq.

3rd. R. L. J. Ellery, Esq., Government Astronomer, read a paper "On Saxby's Weather System." The purport of the paper was to show the vagueness of Mr. Saxby's generalities, and the looseness of the so-called system in deduction, and the unscientific character of his prognostications.

21st November. A. K. Smith, Esq., C.E., read an elaborate paper "On the Underground Drainage of Melbourne."

This was the last paper of the session. Total, nineteen papers, besides adjourned discussions. But not alone in papers read before the Society have our members been advancing science during the past year; for I have to direct attention to several works which far overstep the limits contemplated at our meetings, and by our Transactions. Still, most certainly, it belongs to an occasion like this to notice them, because they advance objects which the Royal Society embraces, and proceed from members actively in communication with it.

First of these is an elaborate work by the Rev. Julian E. Tennison Woods, of Penola, on the Geology of Certain Parts of South Australia, a work which has been received both in Europe and this coutry as an important contribution to geological science, and calculated to throw light upon several misty points in the general geography of Australia.

The next in order is the fine volume which has been placed in my hands by its learned author, for presentation this evening, on "The Plants Indigenous to the Colony of Victoria," and comprising sixty-six lithograms, described by Dr. Ferd. Mueller, Ph. D., M.D., &c., one of my most illus-

trious predecessors in the chair. Being enabled to place it before you for inspection, I am spared a task that I am hardly at all able for, viz., attempting to give you an idea of its utility, or of the most exquisite manner in which the plates have been prepared and executed. It may be doubted if any work exists on which so much labour has been bestowed to render it scientifically correct in its minutest details of phytographic diagnosis. From the same author we have the fifth part of "Phytographiæ Australiæ," and "A Monograph of the Plants of the Chatham Islands." All these works need no praise that I can bestow upon them.

We have also "A History of the Discovery and Exploration of Australia, by the Rev. Julian E. Tennison Woods, an account of the progress of geographical discovery in that Continent to the present day," a work which bids fair to be a standard of reference on many matters treated in it. But concerning one subject—the fate of Burke and Wills—I feel it my duty to state my regret, that this talented but youthful author should have lent himself to abuse the Exploration Committee, and to write for sensation. As soon as he approaches the subject of the Exploration Committee, we have a direct insult put upon those gentlemen, and then comes the prophet's tale of lamentation, and weeping, and woe. For his own sake, I will indulge a hope that he never saw, or at least not in time to prevent his unqualified statements about the conduct of the Exploration Committee from appearing in print, the address of my learned and eloquent predecessor in this chair, Professor M'Coy, delivered this time last year, which supplies much information which as a member of the Exploration Committee he was not called upon to meddle with, but which as President of the Royal Society, in adverting to the conduct of the Exploring Expedition, he had a perfect right to disclose. This portion of his

address clears up, to my mind, every doubt which non-members of the Committee might entertain.

A member of that Committee myself, I take to me my share of blame, if there be any, arising out of the sad fate of the Explorers. It is on record that I proposed the leader for election, and there is sufficient also to show that had Mr. Burke acted upon the instructions which I embodied in a minute, and which stands on the records of the Exploration Committee, probably the sad tale of his end, and that of at least two others dear to this Society, would, under Providence, have never need to have been written.

But whether or not, the author of such a work as that upon which I am making a passing observation, should have dealt very carefully with every circumstance hitherto known of the end of the Explorers, and still more so with the reputation and feelings of the members of the Exploration Committee.

It is not my business now to enter into a discussion of these questions, nor to defend myself or any colleague of mine, but I will say this, that I believe, whoever dispassionately looks at the case as stated in Mr. Woods' volumes, will regret the absence of that judicial mind and temper which should always be most carefully maintained when contemporaneous subjects are under consideration.

One regrets that he forgot what some one said about 'Time' being the beautifier of the dead, and that said 'Time' has had no chance yet of doing its amiable office either for Burke or the members of the Exploration Committee.

I am thus lengthy on this work and its talented author, because he has evidently been inspired by feelings other than those which should sway the historian. And seeing that 'history' in its proper meaning could not yet be written of the first successful crossing of Australia and of the fate of

those who first performed the arduous feat, because the whole of the concurrent circumstances are not yet fully before the world—would he not have acted wisely and praiseworthily if he had given such account of the lamented death of Burke and Wills as his work seems to need, in the spirit of Wordsworth's beautiful reflection on the doings of nature amid ruins :—

> "Softening and concealing,
> And busy with a hand of healing."

Gentlemen—In concluding this brief address, which I have purposely confined to the labours of the Society, and of members of the Society, permit me to hope that the year on which we are entering will bring out its fruits in due season.

JOHN J. BLEASDALE, D.D.

Art. I.—*Victoria as a Field for Geologists.*

By Thomas Harrison, Esq.

[Read 22nd May, 1865.]

There is a strong disposition abroad to underrate whatever appertains to the circle immediately around us. The term "colonial" has long been regarded as one of contempt. We mentally, if not openly, despise everything to which the objectionable adjective can be attached, from colonial legislative assemblies down to colonial ale and porter.

I should have left this matter unnoticed, especially in the Hall of the Royal Society, but not a few persons seem disposed to take like views of scientific phenomena witnessed in this part of the globe, as though colonial laws of nature were something different from, and not to be spoken of in the same breath with, similar laws as manifested in older communities.

I shall leave it to Mr. Ellery to say whether there is nothing worth examining in our heavens; to Professor M'Coy to tell us if he discovers aught worth noticing in our fauna; to Dr. Mueller to stand forth as the champion of our botany; and to doctors of medicine generally, to witness if our especial and peculiar pathology is, or is not, worthy of their attention as men of science; and to-night my story must be that of our rocks and fossils, a story which I think will prove of interest, if I do not mar it sadly in the telling.

That a picture may be pleasing and artistic, it should embody both harmonies and contrasts. There must be portions where the lights and the shadows are brought into forcible opposition, and there must be portions, also, where the same melt, almost imperceptibly, the one into the other. In choosing a suitable field for scientific enquiry something similar is looked for. We expect to discover what is altogether new, forming the contrast (what an artist would call his "strong points"), and to meet with many phenomena, which prove old acquaintance, which, in like manner, answer

to the harmonies equally conducive to picturesque effect. To show that discoveries of both these kinds are likely to reward the Geologist in Victoria is the task undertaken in the present paper.

Commencing with what is commonly looked upon as the very lowest rock, we find that granite is by no means sparingly developed in this portion of the world. Generally, however, it is not a favourite subject for study. In most text books the same is regarded as a sort of foundation upon which the entire superstructure of geological formations is erected; the floor on which the newer rocks have been spread out, if not the grand storehouse from which the debris—now hardened into stony masses—has been obtained. It is often, furthermore, spoken of as the solidified crust of a once entirely molten globe. Because this last opinion is just now rather warmly controverted, the careful study of granite bids fair to become one of more than ordinary interest. It is, you will remember, commonly formed of three separate constituents, quartz, mica, and felspar, and these are not found to assume any definite order, but are promiscuously scattered, in distinct crystals, throughout the entire mass. This arrangement was long supposed to be a result of the separate ingredients crystalizing while the whole, under enormous pressure, cooled slowly from a state of fusion. It is argued, however, by no less a chemist than Dr. Percy, that the contained quartz, at least, is evidently rather of aqueous than of igneous origin. In support of this theory, quartz, or more properly silica, is said to assume two separate forms, the crystaline and the amorphous. The former, in which is included flint and chalcedony, together with regularly crystalized quartz, has a high specific gravity, 2·6, is almost insoluble, even in hot alkaline solutions, and has often been most unmistakably formed from a liquid menstrum. The latter variety, on the other hand, is of low specific gravity, 2·2 or 2·3, is soluble to a great extent, and is the very form assumed when small particles of silica have been melted by an intense heat. Now the quartz of granite is ever of the former, and never of the latter kind, and, whilst distinct crystals of quartz have been repeatedly produced in what is called the wet way, all attempts to obtain them by fusion have signally failed.

The foregoing is one of the objections recently raised against the old fashioned theory. Further occasion will be given for alluding to the subject under the head of quartz

veins, but respecting the tenability of the hypothesis I must not venture an opinion. My reason for alluding to it at all is, to show that in any discussion of that matter that may arise, we Victorians are not likely to be shut out of the controversy by lack of materials for study or illustration.

On this granite as a foundation are superimposed the palæozoic, if not the azoic strata. Whether the latter really deserve the name, and were actually laid down previous to the existence of life upon our planet, is a question which Victorian observers may aid in solving. Rocks barren of fossils in one land may be filled with organisms to repletion in another. Miners, therefore, whose occupation leads them to delve deeply into these ancient deposits, may, I think, really serve the cause of science not a little by carefully noticing whether the rocks do, or do not, present traces of a life long since passed away, and which, in most parts of the world, has left no record of its existence whatever.

With the lower silurian beds the work of the palæontologist really commences. In a brief essay (which I have never read without anathematizing the powers that be for not allowing it to be longer) attached to the Catalogue of the Victorian Exhibition for 1861, Professor M'Coy particularizes no less than eighteen distinct species of graptolites, strangely matching with those of similar beds in Europe, America, and other distant portions of the globe. What is still more singular, associated with particular kinds, *Diplograpsus, mucronatus,* and *D. pristis,* there is found in the Bala strata a small bivalve *Siphonotreta micula,* whilst in similar slates in Victoria the same forms of graptolite have been met with, and, strange to say, similarly associated. The *Orthoceras bullatum,* peculiar to the Ludlow rocks in England, has been met with in the equivalent beds of Collingwood. At Broadhurst's Creek, near Kilmore, the trilobite *Phacops longicaudatus* matches with the same species from the Wenlock shales of Shropshire. Not long since, too, I had the especial good fortune to meet with, in the Moonee Ponds cliff, more than one fine specimen of *Homolonotus delphinocephalus,* a kind of trilobite which seems to be losing the distinguishing marks of its family (for the trilobation is almost obliterated), which is especially characteristic of the Upper Silurian strata, to which the Moonee Ponds beds belong. In the same locality I also found numerous specimens of a small species of encrinite, which, if I did not misunderstand him, Professor M'Coy considers identical with a species lately brought to

light in Canada. With these old fashioned forms, however, are found other organisms altogether strange, some of which, to quote, I think, Mr. Selwyn in the *Journal of the Geological Society*, are not only of entirely new species, but require, in order to class them, that new genera should be formed.

The former of these instances illustrates the harmony referred to. The latter, in like manner, is no less typical of the contrast. The one singularly proves the unerring truth of sound palæontological deductions. The other offers to the votary of the science "fresh fields and pastures new" wherein to prosecute his studies, ever giving promise of discoveries which are the legitimate and sure reward of all searchers after knowledge made in a right direction. In the first case we are startled to find that, at that distant period, countries so widely separated as England, Canada, and Australia, must have enjoyed an almost identity of climate. In the second we are delighted to meet with fresh proofs of that almost infinite variety, characteristic of nature's works, from the earliest geologic ages down to the present time.

I had intended to speak of the somewhat remarkable contortions peculiar to the foregoing rocks, and to offer a few remarks upon what, to me, seems to have been the cause of them; but I hope, ere long, if you will allow me, to submit to your notice an especial paper upon the subject. The contortions in question have, however, left traces of a bygone physical conformation of country, which I am strongly tempted not to pass unnoticed.

The scenery of the greater portion of the colony presents but few bold features. Were it not for a number of mammillated volcanic hills, the whole of the district south of the Dividing Range would have the aspect of a widely extended plain. This, however, could not always have been the case. Near Johnston-street bridge, for example, there is a deep cutting extending from the Yarra, for at least half a mile, into Studley Park. During the first few hundred yards the beds, nearly perpendicular, lean slightly towards the east. They then form a sort of anticlinal, the beds on the side nearest Kew dipping in an entirely opposite direction. Now the beds being at one time horizontal and continuous, must have been broken over the knife-like edge of the anticlinal, forming, hereabouts, a valley of fracture, bounded on the east and west by two lofty hills, several hundred feet in height. This will appear at a glance by the

section before you. A similar cutting off of the crown of a hill is shown at Moonee Ponds, at Aitkin's Gap, and in numerous parts of the colony. Picture, then, this same district in its pristine state and elevated as dry land. We shall have a scene remarkable for its picturesqueness. Broken up by hill and dale, the mountain tops attracting the cloud and courting the shower; down the sides of the steeper precipices would roar the torrent, and along the valleys would flow the stream; the whole having a climate strangely different from that of Australia now. Partially sink the area, and there would appear an archipelago of islands, with winding channels, deep bays, and romantic fiords, bounded by rocky shores slowly crumbling away. Submerged still further, and Victoria will be an ocean bottom of varying depth, generating currents, and forming the habitat of strange denizens of the waters, as these preferred homes upon the foam-washed rocks, or in the deeper sea.

This, the Silurian, formation is of great practical interest, from the fact that it is the original matrix of the quartz reefs whence all our auriferous treasures are derived.

First of all, then, a question of great moment presents itself. Do the reefs referred to, or do they not, decrease in productiveness as they descend? Not a little has been said upon the subject, and not a little bad temper towards geologists has been displayed. It is a problem the practical importance of which I can indicate to you, even whilst no attempt is made to afford an answer. In cases where I have put pointed queries upon the subject, the replies received have been various and conflicting. One thing, however, I often noticed. Those having shares to sell were much more enthusiastic anti-Murchisonians than those who wished to purchase.

But there is another question quite worthy of the geologists attention, namely, the probable origin of the quartz veins themselves, and how the same first came to be impregnated with the precious metal.

Before you is a quarter sheet of the Government Geological Map, showing the district near Castlemaine. The purple tinted portions indicate the development of the Silurian strata. Over these parts are scattered a vast number of black lines, looking, as they are drawn, not unlike the flights of arrows in some ancient battle piece. These are quartz reefs. They have nearly all a meridional direction, a feature in reefs by no means peculiar to this district alone.

Here again are respective sections of Steiglitz, Sandhurst, and Ballarat. The purple tints also represent the Silurian rocks. The blue branching lines, crossing the strata, are the same quartz veins as viewed in section. A little attention will lead one to conclude that these veins are simply fissures, subsequently filled up, and, as I imagine, that the filling up has taken place from below, and not from above. The Huttonian school, of which Mr. Rosales appears to be a disciple, refer the filling up to masses of heated and molten quartz, just as, on a small scale, fluid metal runs into the interstices of a mould, or, on a larger one, trap dykes are formed in the fissures of modern volcanoes.

Mr. Davison, referring to the origin of gold-bearing veins, supposes that the quartz and the gold were together forced up from beneath, whilst both were in a liquid state, by some powerfully eruptive force. So long as the quartz continued to flow upwards it might reasonably be expected to hold the contained gold in a state of suspension, but when the force below, and with it the upward motion, ceased, the heavier substance, that is, the gold, would naturally sink downwards by virtue of its superior gravity. Some portion of the mixture would be forced completely outside the fissure, and the gold contained therein, the quartz being subsequently disintegrated, would give rise to the rich gutters and nuggets peculiar to what are known as the deeper leads. The top portion of the vein would cool rapidly by contact with the atmosphere, and the fluid thickening, must necessarily entangle much of the gold, thus preventing its sinking downwards, just as rapidly as cooling wax retains in suspension shots which otherwise would sink speedily to the bottom. This portion of the vein being in time broken up, would form gold drift No. 2, generally of great richness, but inferior in productiveness to the one below. Then in time the lower, and, consequently, the poorer part of the vein, would be worn down, giving rise to the upper drift, still poorer, but apparently more productive of larger nuggets than any portions of the reef now remaining *in situ*.

This is a somewhat ingenious theory. It accounts for the presence of the gold, and for the supposititious phenomenon that the same becomes less plentiful as we descend. It explains, too, the schlicken or scratched sides found on many reefs, for if the reefs were thus once heated, they must necessarily contract greatly after their formation, and so contracting, would grate against the adjacent rock; hence the

longitudinal striæ now characterising their casings; whilst the whole is strictly in accordance with the Huttonian hypothesis. The pity is that there are a few facts telling much more against the theory than in its favour, as, for example, close adjacent to the veins themselves—I quote Mr. Selwyn's speech before the Mining Institute, reported in the *Mining Journal*—are found delicate fossils still unchanged in any way; a proof, it would appear, that the strata have never been subjected to the intense degree of heat supposed. Then, again, there are branching veins so thin that they never could by any possibility have been filled in as molten material, since such material cooling would have solidified and choked up the passage, as a long thin mould will cool and choke up during a casting. But, lastly, it is urged by Bischof, that the rocks which the veins traverse are often composed of materials, allumina and lime, which readily form a mixture with the silica, more easily melted than is either silica, lime, or allumina by itself.

"If," says that writer, "we pour molten silver into a mould of lead, part of the lead will be fused and form an amalgam with the silver, so we may expect that, if formed as supposed, by igneous agency, instead of pure quartz veins, there will be found veins composed of quartz in a state of mixture with more or less of the materials of the rock through which they pass."

Setting on one side the igneous theory, it is most natural to refer the phenomena to the action of water.

If, however, quartz is difficult to fuse, it is still more difficult to solve. Nevertheless, although this is the case with the pure material, the same, mixed with proper fluxes, is easily reduceable. Together with potass or soda it forms glass, a by no means refractory substance. Whilst, by increasing the proportion of alkali, we actually obtain a substance not only readily fusible, but capable of being dissolved and held in solution by either hot or cold water. It is, in fact, the water glass, well known in the laboratory, and lately brought into notice from its supposed quality of hardening and preserving otherwise friable sandstone.

Some few difficulties, too, of the aqueous theory have lately been explained away by a tolerably well-known process, alluded to by Dr. Percy, in his late course of lectures on Chemical Geology.

If to an aqueous solution of water glass, which may be perfectly clear, we add, in a certain manner, an acid, the

same will combine with the alkali present, and the contained silica will be thrown down in the form of a jelly. But when the acid is added in another way, the silica is not precipitated. If, then, we take a small hoop of gutta percha, having a bottom formed of parchment paper, and place the same floating in water, and if, whilst so floating, we pour into it some of the last mentioned liquid, we shall have the following result. The acid and the alkali will pass through the paper, as will also a small portion of the silica, but another portion of the latter will remain and be suspended in the water. In many instances as much as six per cent. remained so dissolved, and that without there being the slightest particle of base to thus keep it in solution. This is the process of dyalisis, and when, as is stated in the lecture referred to, it is found that all the conditions of the artificial process are likely to exist in a state of nature, there is reason to suppose that the solution and redeposition of vast masses of siliceous matter, by aqueous agency alone, are by no means so difficult as was once imagined.

There is another way, but as I have never heard the same put forward by any writer on geology, you will please to receive the same with caution, and consider it rather as a query put to elicit truth, than as a dogmatic assertion explanatory of a difficulty.

May not both aqueous and igneous agency have come into operation? May not the silica, mixed with lime, alumina, and potass, as fluxes, have first, as a fluid mass, filled the fissures; and may not the same have been subsequently metamorphosed and altered to its present form by the removal of the flux in question?

As bearing upon this portion of the subject, permit me again to draw an illustration from Dr. Percy's lectures. It is the account of an experiment descriptive of the artificial production of staurolite. A porcelain tube was taken, and after being filled with alternate layers of alumina and silica (as in sketch), the whole was placed in a furnace and maintained at a red heat, whilst a continuous stream of fluoride of silicon was made to pass through it. On the tube being broken up, it was found to contain, not separate layers of the two elements, but a compound formed of both silicate of alumina or staurolite, as required. The rationale is as follows: The fluoride first deposits its silica in the alumina, taking up alumina instead. It is then fluoride of alumina, and passing on through the next layer it is changed back to

its original form, fluoride of silicon, by giving up the alumina, and re-appropriating the silica to itself. This process is repeated many times in passing through the tube, and at last the gas issues from the one end as it entered at the other, fluoride of silicon.

Here, then, is a metamorphosis not unlike the one required. There are plenty of veins, too, answering to the supposed first condition of the reefs of quartz, and veins generally referred to igneous action. Such are the elvan dykes, the principal constituents of which are, if I am not mistaken, silica and potass. There are two of these dykes near the Botanical Gardens, two cross the Moonee Ponds Creek above Flemington, and others are by no means uncommon in various parts of the colony. We now want some permeating gas or fluid to remove the foreign substance, so as to leave the quartz in a state of purity. This requirement might, perhaps, be met by high pressure steam or superheated water. The whole, however, is, as I told you, merely suppositious, and you will therefore discuss it or dismiss it as unworthy of notice, as seems most fitting to you.

Near Bacchus Marsh, in the gorge of the Werribee, rocks are met with which Mr. Daintree classes as upper palæozoic, and speaks of as possible equivalents of the old red sandstone. It is this same series of strata which, in Great Britain, were once thought to be barren of organic remains, but which yielded the Scotch geologist, Hugh Miller, such an abundant harvest of unique forms. It will be interesting to see whether still fresh additions to the ichtholites of the period are to be made by the Victorian beds, and to observe what novel shapes the *plerichthys* or *cephalaspis* will take when located as denizens of the Antipodes.

By the Geological Map I see that these same beds are classed as permian, so that it may be supposed their age has been determined by the geological survey. They present, however, another problem of no little interest. Are they, or are they not, auriferous? Mr. Daintree speaks of them as "seen resting on the upturned edges of the silurian slates and sandstones, with their associated quartz reefs, which do *not* pass into the overlying conglomerates (*i.e.*, of the permian beds). The drift of the valley has been worked for gold, proving the auriferous character of the reefs; and here we should be able to work out the relative age of the gold." And this question, especially as viewed in connection with the theory of quartz reefs being richest near the surface,

is one of no little practical importance. If, as I think, we must conclude the lowest tertiary drift is the richest, because it is formed of debris gathered from quartz lying high in the reef, how much richer may we not expect to find that drift which, by being accumulated in palæozoic times, must necessarily have occupied a much higher position, and, consequently, have been still more charged with auriferous particles. The difficulty will be to find this drift, hid as it must be below vast thicknesses of the old sandstones.

Upon this series of rocks repose the so-called carboniferous strata of the colony, and which are generally referred to the mesozoic period. The true age of our own beds seems now to have been definitely settled, but this is scarcely the case with what may be termed the kindred deposits of the sister colonies. In Hobart Town are a series of sandstones, shales, and coal seams, very like our own. They lay conformably, though at some distance above, a deposit of lime-stone, thought to be Devonian, or at least lower carboniferous. It is hardly to be supposed then but that these facts, together with the often-cherished overweening desire for an ancient lineage, should induce our neighbours to go just a little mad, or at least to display a little amount of unreasonableness, in claiming a high antiquity for the ground they tread on.

In a former paper, read before this Society, I mentioned the finding of certain Batrachian remains in these beds, which go far, as it would appear, to settle the disputed point, and prove that the coal is rather of the secondary than of the true carboniferous period.

In New South Wales the same question is by no means so nearly decided. Great authorities declare for the beds being mesozoic, and great authorities also have declared the other way. I hope to show you the practical bearing of all this directly.

We have here, then, in two out of three colonies, coal beds known to be mesozoic, and in the third, large deposits of coal which is said to be of the true carboniferous type. In no country does it appear that the newer deposits of coal equal the older in richness ; and in this part of the world, what are said to be of the latter age are by far the most extensive. In Victoria, the whole of the carbonaceous rocks (Oolitic) are but sparingly developed. If no really palæozoic coal is discovered in any of the adjacent colonies, the natural presumption is that, at the time when the true carboniferous

vegetation flourished, this continent was either sea, or not in a condition to nourish that especial vegetation so luxurious elsewhere. All hope, therefore, of finding palæozoic coal would seem in vain, and no one would care to look for the mineral out of what are known to be mesozoic districts. But say that the Sydney beds are really of the older class. Then there is proof that some part of Australia has been covered by *bona fide* coal plants, and there is reasonable ground for hoping that in our older rocks, the sandstones of Bacchus Marsh, of the Grampians, and of North Gipps Land, rich deposits may be found entombed, and rivaling in value and importance the stores of mineral fuel incidental to England, to America, and to Continental Europe.

And if the other theory, that the Sydney coal is Oolitic equally with our own, be true, is there nothing gained—practically, I mean—by having the matter decided? Is the whole a mere question for dilettanti geologists to squabble over? I think not. We shall be something like a merchant who, in the midst of a crisis, takes stock and finds his balance on the wrong side. Not a pleasant discovery, but far better than ignorance as to the real state of affairs. It is the coward only who flies to the opiate or to the brandy bottle in time of trouble. The brave man longs to see the danger, so that he may face it, and by facing it boldly avert it wholly.

Above the last mentioned rocks there occurs a blank. The upper Oolitic and all the Cretaceous group seem, in Victoria, to be wholly unrepresented. In our tertiary deposits we stand once more upon old and well-known ground. The clay beds of Mornington appear the probable representatives of strata found below both London and Paris. The lower miocene near Geelong presents us with a fauna of a very decidedly tropical character. The more singular and the more interesting since, by the equivalents of these beds elsewhere, such climate seems in that age to have been almost universal. Even the more superficial deposits of our continent present features well worthy of consideration. In the pliocene drift of Queensland and of South Australia, there occur bones of gigantic mammals, worthy contemporaries, as you can see by comparison of their respective crania as preserved in our National Museum, of similarly gigantic fossil animals found on other continents. Nor is it less remarkable that, as in South America, the huge Megatherium, by its sloth-like form, was evidently closely

allied to the sloths which have succeeded it on that continent; so our own Deprotodon, by being a marsupial, seems a fitting prototype of the Australian mammals of the present epoch. I cannot see my way at all clearly as a developmentist, but I am greatly mistaken if the above-mentioned fact does not tend, at some future day, to throw no inconsiderable light upon the origin of special forms in creation.

I have been thus brief in treating of the tertiary rocks, not because they are devoid of interesting features, but that my paper is already extended to inordinate dimensions, and there is yet much to say.

Interstratified with these last, the tertiaries, is a class of rocks, the basalts, of quite another character to any yet spoken of. I need hardly tell you that these are certainly of an igneous origin. They are of varied ages, and occupy no inconsiderable or unimportant position in Victorian geology. A glance at the map will show their conformation, and the very wide tract of country which they cover. In fact, nearly the whole of South Western Victoria is occupied by them, either as a superficial stratum, or as overspread by a thin capping of tertiary deposits.

The basalts are singularly interesting, by the light they appear to throw upon the power of water to erode and eat away the most indurate materials. This is especially noticeable along the coast line near Cape Schanck, where high cliffs of this rock are worn and fretted into shapes the most fantastical. At Fyan's Ford, near Geelong, similar results are apparent, the more remarkable that here breakers and waves could have played no part, and that what is witnessed is simply traceable to the trifling, though continual, action of a tiny stream. At Keilor, too, there is a deep and wide gorge, referable to the same causes. No. 1 represents it in plan and in section.

The cliffs on each side are formed of three different layers of strata, each of which must have been continuous across the valley. At the base is seen the Silurian strata, much contorted. On this reposes a tolerably thick bed of siliceous tertiary rock (the most indurate I ever saw), and on the whole is superimposed a layer of basalt. The entire cliff must be over a hundred feet in thickness, yet the valley bounded by it has evidently been scooped out by the action of the insignificant stream of the Deep Creek, and it is difficult to conceive how that stream, with the present configuration of country round, could have been much greater

than at present. Our only resource, therefore, is in an extension of time, and an extension of time so vast that the geologist, pretty well used to contemplate lengthened periods, and the astronomer, who is alike accustomed to meditate upon space as of infinite extension, stand aghast at its immensity.

And yet these same basalts are some of the newest rocks of Victoria. We frequently hear of wood, similar to that still found in our forests, being dug up from beneath a hundred feet of tertiary gravel and bluestone. Near Warrnambool dried grass is found below a solidified stratum of lava. Even the beds lying beneath the basalt of Keilor are all of the newer tertiary epoch, so that this work of denudation and cutting through the three several masses of strata spoken of must all have been accomplished since the time when the English crag deposits were laid down. But the time elapsing since this period is but an infinitesimal fraction of the whole geologic epoch. Who then shall count the ages which have rolled slowly onward since the primeval granite nakedly bore the brunt of the first tempest, and the first atom of azoic strata found a resting place in some sheltered nook of that ancient ocean.

A few mails since I had the honour of receiving a letter from Professor Rupert Jones, in which he remarked upon the especially interesting features manifest, as illustrative of the modern theories of erosion and fracture, in the gorges referred to ; at the same time expressing a hope that Victorians would not only carefully observe them, but also communicate the result of their observations to the English scientific world. I mention this, to show that in our own, and by many, despised geology, there are peculiarities which the princes, if I may so speak, of European science would be only too ready to explore.

The same strata are interesting also as being the proximate cause to which our capabilities as a corn, oil, and wine producing country are clearly traceable. In Kent and Sussex rich agricultural land is formed by the natural admixture of debris from Wealden, Greensand, and Cretaceous outcrops. Scotland owes its fertility to the boulder clay. Egypt is rendered the corn-field of Africa by a geological cause also—the periodical deposition of mud from the waters of the Nile. The barrenness of our own tertiaries is counteracted by a provision equally geological and equally efficacious, yet a provision which in the process of its development promised

but little, nay, which seemed rather likely to result in a region especially blasted and desolate.

The philosopher, eager to trace the harmonious working of cause and effect, could not but have been charmed to witness the grand chain of events as hitherto developed, events sublime in their monotony, and interesting even in their sameness ; but the most enthusiastic optimist might be excused for a feeling of despair whilst surveying what had been done and what so far had resulted. It was (previous to the era of these last igneous rocks) the chapter of Victoria's history where all grew most confused, the act of the great drama where all appeared most disheartening. There had come to be a state of climate, of animal life, and of vegetable existence, suitable to the wants of man ; but this especial scene could surely never be rendered a fit place for man's habitation. Many changes had occurred, but none seemed for the better. In place of the desert of one rock there had come to be the desert of another, or at best, wide arid wastes. On the former, trees of stunted growth might stud the surface. On the latter, a little grass or heath, like that near Brighton, would struggle for existence. Nature working so slowly, yet so surely, now seemed to have worked in vain, and each new point rising above the waves appeared but as a region of desolate rock, or gave rise by decomposition to dreary dunes of blown sand.

And then the time seemed to have been fulfilled. The natural forces, which hitherto had acted quietly and silently, now swelled the district into hills, and split the surface into chasms. A little smoke would give the earnest of the coming storm, then a shower of ashes, thrown from a newly formed crater, would blast the forest and overwhelm the plains, and lastly, amid the thunders of volcanic eruption, would be poured forth the stream of fluid lava. It would flow onward in a desolating scorching flood. It would lay long as a wide-spread molten lake, on which no breathing thing could pass and live. Then, cooling slowly, the same would remain for ages as a black cindery mass, a Sahara in barrenness, a Gomorrah in desolation.

Then, at last, just as the old granite hills slowly crumbled and yielded their *debris* to form the lower rocks, so would this solidified lava also be disintegrated into mould and clay, slowly but surely forming a soil above the indurate mass below, and the succeeding changes of almost infinite ages thus culminated in developing the fertile district of Victoria,

which future generations, if not our own, will see, fruitful with the olive and the vine, blessed as the beauteous home of a prosperous and happy people.

I feel, gentlemen, that I owe the Society an apology for this long and discursive paper, one, too, in which I fear the professed geologist will find but little that is new. My object, however, has been to indicate where enquiries can be made, rather than to offer any very profound theories or very novel facts. I have long felt that the particular science, the claims of which I advocate, has been too much neglected in this colony. That profit and pleasure are to be derived from its study is what I have sought to show. Its use must be patent to every one who looks upon our own as a mining or an agricultural country. When a Victorian Miller or Mantell shall arise amongst us, such individual need be at no loss to find materials for a work quite as interesting as the *Old Red Sandstone*, or the *Medals of Creation*. Such a treatise may have all the charms of an imaginative work without departing from the strict line of geologic fact. But until this comes we need not be idle, nor on this subject need we be dull. Our stony treasures are as great as those of other lands. The story of our rocks and of our fossils is well worth listening to, or even digging out if requisite. The field is a rich and an ample one. He who toils in it enthusiastically and with a will, need not toil in vain, for of it may be said, "The harvest is indeed plenteous, though the labourers are few."

ART. II.—*On the Probable Erosion of the Mountain Ranges of Gipps Land.* By THOMAS E. RAWLINSON, ESQ., C.E.

[Read 3rd July, 1865.]

Having had occasion during the latter half of the years 1862, 1863, and beginning of 1864, to travel over the country lying between Sale and Jericho, in various directions, my attention has been directed to the peculiar character of the mountain fastnesses of that region, and also to some extent to the mountain ranges extending northerly from Sale, as a centre, up into the Omeo country.

It is not my purpose to do more to-night, than allude generally to the similar external character of the Omeo routes with those of the country traversed by the tracts to

the Jordan. I may remark, however, in passing, that in both localities we have large tracts of country traversed and interlaced, by a net-work of ridges and ravines, of a most impracticable character generally, owing to their precipitous slopes and the dense growth of the scrub, brushwood, and timber with which they are clothed, from the crests of the highest peaks down to the bottom of the deepest ravines. To the explorer, when first attempting to penetrate these ranges, their aspect is most disheartening, owing to the difficulty in tracing any connected system of ridges on which to travel, without which progress is exceedingly slow and wearisome, the valleys (or gullies) being utterly impracticable when in a state of nature.

A very remarkable feature throughout these mountain systems, in so far as I am acquainted with them, is the entire absence of lakes or even small bodies of impounded water, beyond the mere water-holes which exist in the rivers and rivulets, while in most other mountain ranges, such, for instance, as North Wales, Westmoreland, Cumberland, the Highlands of Scotland, and the mountain districts of Ireland, and of Europe; in fact, generally where mountain ranges occur, it is common to find numerous lakes in greater or less areas, impounded at varying altitudes, whilst amid our mountains, the absence of such bodies of water is the rule.

In calling attention to this fact, it will scarcely be necessary for me to remark, that if our mountain chains had been the result of ordinary volcanic agency, as generally understood to operate, in the shape of forces, acting with greater or less activity at certain points, and along certain lines, rupturing and dislocating the superincumbent strata, with greater or less violence, we should naturally expect to find along the courses of such dislocations, and their intervening valleys, natural barriers to the passage of the spring and drainage waters, and from such a cause we should have lakes of greater or less extent and depth; and such not being found, it is difficut to reconcile the existence of our present system of mountain ranges, with any but very gentle and long-continued sources of action, which must have required ages before any remarkable change was effected, and the same causes may at this moment be in slow operation beneath our feet, without mankind being in the least conscious of any change for centuries to come; in fact, such an elevation would in all probability be due to chemical rather than to igneous

action. Any indication of further continuance of such gradual action would be most likely first made known to us by the derangement of the instruments in the Melbourne Observatory, in some sensible manner.

The glacial action which has been so influential in abraiding and scooping out the valleys of other countries, must in our case be omitted from the list of causes, for I have neither seen or heard of any indications of such action, in the existence of moraines, or other evidence of the former presence of glaciers. Nor do I think that the valleys and river courses generally, could have their present form and character, had such agencies been concerned in their excavation.

Having thus far touched upon the negative aspect of the question, I must ask you to follow me during a brief description of the physical features of the country from Sale westwards and northwards towards the Dividing Range, being a distance of from seventy to eighty miles, having Mount Wellington on the north-east, the Baw Baw on the south-west, Mount Useful near the centre, and the Bald Hills on the divide, being the extremity of the area proposed to be described.

From Sale westwards, for from twenty to thirty miles, extend the plains, consisting of agricultural and pastoral lands, watered by the rivers La Trobe, Thomson, and the Macalister. The waters of the La Trobe flowing through extensive morasses, reaching from the foot of Mount Baw Baw down to the Coast Lakes, a distance of about seventy miles. At from twenty to thirty miles distance from Sale, the plains terminate and the hilly country begins, the portion between the Thomson and the Macalister being much more broken and irregular than that between the Thomson and La Trobe. For a further distance of about thirty miles to Mount Useful, a long and continuous spur has been explored, with branch, and sub-branch spurs, to the right and left, interlacing to a considerable extent, but preserving a general direction with the decreasing elevation of the ground, from Mount Useful eastward.

It is not until we begin the last ascent on the flank of Mount Useful, that we are enabled to obtain a good view of the valleys of the Macalister, and its dividing spurs in the amphitheatre of the dividing range, of which Mounts Useful and Wellington form the outer points of the crescent, whilst from the summit of the former an extensive view is

afforded of the valleys of the Thomson and its tributaries, embayed in another crescent of which the Baw Baw forms the southern extremity.

From a more westerly station on Mount Useful, a view is afforded of the connecting saddle between the mount and the dividing range.

At a first glance from Mount Useful the impression left upon the mind is, that the mount forms the central point of two semicircular basins, in form like the double bow of the letter B; the outer points terminating in the Baw Baw, and Wellington, distant respectively about 12 miles and 20 miles, whilst along the centre of each semi-basin, several lines of densely timbered ranges extend, in the general direction of the open sides, and thence in a more or less connected manner, continuous with the wooded ranges covering the face of the country eastward, until in the far distance the open plains can be seen in brownish patches; and beyond, the waters of the shore lakes and the ocean.

The above impressions, whilst generally correct, are only partially so, for upon careful examination, it is found that the semicircular basins, or mountain enclosures, are irregular in outline, and interrupted in places by deep ravines and gorges; whilst the apparently isolated mountain chains, occupying the centre of the basins, are in reality, huge spurs connected with the main range, by saddles of greater or less elevation, with lateral and sub-lateral spurs branching from them, in the most erratic manner, the only appearance of order being the general tendency of direction towards the lower country of the plains. Mount Useful itself is but a huge peak on a main spur from the dividing range, whilst the Baw Baw and Mount Wellington are terminal peaks, which rapidly run out into main spurs, from which leading and subsidiary spurs ramify, and ultimately terminate on the plains.

From Mount Useful huge spurs are thrown out on three sides, the chief one extending south westerly (dividing the waters of the Thomson and the Macalister Rivers), down to the plains, with its ramification of branch, sub, and sub-sub-branch spurs, and forks; forming a complete network, and yet preserving a general direction downwards to the plains.

From the Bald Hills on the divide, a huge spur is thrown out with very large branch, and sub-branch spurs, interlacing with each other, and with those thrown out from Mount Useful on the one side, and the Baw Baw on the

other, but still maintaining a general direction of south east, until it terminates from 12 to 14 miles south-east of the summits of the Baw Baw. This spur divides the waters of the Aberfeldy from the Jordan, and afterwards from the Thomson, until the junction of the first and last named rivers.

Throughout the whole of these spurs the general character of the rocks is clay, micaceous, and schistose slates, standing in planes of stratification at gradually increasing angles, until at the mount they are nearly vertical against an outcrop of granite* on the summit of the mount.

The strata around the foot of Mount Wellington I have had no opportunity of inspecting, and have only once passed over a slight portion of the eastern spurs of the Baw Baw; but from the outcrop of white rocks on its summit (supposed to be granite) and from the general aspects of both mountains, I believe it is quite safe for the general purposes of this paper, to assume that their geological characteristics are similar to those of Mount Useful.

After a consideration of the above facts, I believe that sufficient ground is afforded for concluding that the ridges and sub-ridges from the plains up to the divide, may be due to the upheaval of the granite from below (combined with chemical action as before alluded to), and, for the reasons before given, such upheaval has been very gradual during this period, the higher peaks have rendered the process of disintegration and denudation, by the frosts and rains much more rapid, owing to the gradually breaking up of the continuity of the crust over the summits, whilst the former gentle hollows, of the undulating country between the peaks of the ridges of the divide, would gradually be eroded into deep channels by the winter floods, each having a general tendency towards the lower levels of the plains, but, influenced by natural or accidental obstructions, interlacing and working themselves into the winding channels, such as we now find in the gullies and ravines of the district.

As this process went on, the erosion of the gullies and high

* The outcrop, which the author, in a cursory inspection, mistook for bleached granite, proves to be quartz conglomerate.

After the reading of this paper, Mr. Ligar, the Surveyor-General, quoted a general opinion of Mr. Selwyn, that a vast plateau of tertiary, crowned with basalt, had once extended above the level of our mountain ranges up to Mount Kosciusko, of which traces yet exist on Mount Useful, and that this fact was strongly in favour of the views expressed in this paper.—T. E. R.

table lands, would proceed with accelerated speed, from the growth of vegetation, and the storms bursting and breaking down large masses of materials from the steep sides of the newly formed ravines, each mass, in turn, assisting to destroy not only itself, but the other materials obstructing it in its course.

In the earlier ages of such a period as that which we have been contemplating, the flat coast known as the Ninety-Mile Beach, and the coast lakes, with their surrounding low lying land, could have no existence, whilst the waters of the ocean would roll unchecked, up the long narrow valley of the La Trobe, now occupied by rich alluvial marsh lands and back waters, and in all probability the marshes of the Morewell and the Moe, south of the La Trobe would be brackish, if not sea-water lakes.

The material worn out from the former undulating high lands of the ranges, would be sufficient to reclaim the whole of the La Trobe Valley and form the low lands around the Coast lakes—together with the Ninety Mile Beach.

Such are the views I have formed from the examination of the physical features of the district, and although such examination has been of necessity a very cursory one, I believe the views put forward will be found to be supported by a more careful scrutiny of facts.

This paper is in itself somewhat crude, from the want of time for preparation, but such as it is, I hope it will be accepted rather as suggestive of a question of great interest, which deserves a fuller examination and profounder thought than I have been able to afford to it.

ART. III.—*On the Skeleton of the Gorilla.* By GEORGE B. HALFORD, M.D., Professor of Anatomy, Melbourne University.

[Read 24th July, 1865.]

Owing to the energy of Professor M'Coy, Melbourne has been enriched by the acquisition of skeletons and stuffed specimens of the Gorilla; and we are further indebted to him for permitting one of the former to illustrate our discussion this evening. It would not be right were I, comparatively speaking a new arrival, to allow this opportunity to pass without expressing the admiration with which

I always regard our Natural History collection in the National Museum. Nor can I omit to notice the two other glories of the colony, the Public Library and Botanic Gardens. Long may those who preside over museum, library, and gardens, live to reap the honour that is their due.

Of the two Gorilla skeletons in the National Museum, I have made measurements, a table of which will be appended to this paper, but which would be too long and wearisome for your audience. I may observe, however, that the *height* of the male skeleton as it now stands is five feet two inches; that of the female, in the attitude of a quadruped, two feet ten inches. There is some difficulty in making a correct estimate of the height of the living animal from an examination of the articulated skeleton, but we can make a good approximation. I should say, then, that this male would have measured, from the top of the skull to the sole of the foot, at least six feet. I have compared all my measurements of the separate bones with those given by Du Chaillu of a gorilla which, when shot, measured five feet eight inches extreme length. In this male there is a slight increase in some of the *dimensions of the skull*; thus the *occipital crest* is higher, there is an *additional vertebra*, and the *femur is a little longer*. The *skull* of the male differs from that of Man in possessing this enormous *sagittal crest*. This little male Macaque* has a similar, though not so prominent a one. In the female it is absent, but a rough line, meeting at the vertex, indicates its rudimentary character. It is a *sexual* distinction not existing in the young of either sex of gorilla or macaque. Its use is for the attachment of a powerful muscle, with the excessive development of which it rises to move the lower jaw, as in biting. It accompanies a *similar excessive development of the canines* in the male. In the human skull it is only a rough curved line, situated altogether at the side, the greater part of the broad roof lying above it. It is the difference of situation, and not the height to which this crest rises, that is of importance in distinguishing the ape's from the human skull. This great crest meets another, the *lambdoidal*; it is seen in this male macaque, and also, though much less prominent, in the female. No similar ridge exists in man, the occipital and parietal bones being united by suture. Beneath this ridge the posterior

* Skeletons of Man and of Macaque were exhibited for purposes of comparison.

surface of the skull in the gorilla and macaque slopes towards the *foramen magnum*, or place of junction of the cranial and spinal cavities, and is externally concave. In man, this same region is convex. The plane of the *foramen magnum* is inclined to that of the horizon in the gorilla and macaque, and the head is not balanced on the top of the spinal column, as in man ; and in the gorilla, owing to the great development of the bones of the face, requires a development of the muscles of the back of the neck to uphold it, as is evidenced by these brutal spinous processes. The *supra-orbital ridges* are strongly marked, both in gorilla and macaque, and, as has been remarked by Professor Owen, it is difficult to conceive, upon the 'derivative hypothesis,' what external influence could produce them, seeing that they are quite without the influence of any muscular action whatever. Owen says further, that where they bend down to meet the malar bones, and form the outer boundary of the orbit, if viewed from the side, no part of the orbit is seen in advance of this border. In these specimens, however, and in macaque, a small part of the lachrymal bone is still seen. In man, the outer wall of the orbit is less prominent, so that he can, *by simply turning the head, the body remaining fixed, see all points of the horizon*, a provision in harmony with his usual erect attitude, and especially made use of when flying from a pursuer, whether on horseback or on foot, and in the more genial though not less stirring contests of the course, &c. The *Post condyloid process of the squamosal*, or *middle root of the zygoma*, is so large in in both gorilla and macaque as entirely to separate the condyle of the lower jaw from the auditory process, which is not the case in man. There are many points of great interest in this region too minute for notice this evening. The gorilla makes some approach to the possession of a *mastoid process*, whereas in macaque there is none. The articulated condition of these skeletons prevents my following out the comparisons of the interior of the skull. I have, however, in my *Lines of Demarcation between Man, Gorilla, and Macaque*, carefully examined all that has been said on this subject by Professor Owen. As his papers in the *Zoological Society's Transactions* are illustrated, the comparisons are easily made between the segments, sutures, and proportions of the cranial cavity in man, gorilla, and macaque. The differences between man and gorilla in this important region are truly immense ; between gorilla and macaque so trifling, that in

viewing this *basis cranii* of the macaque, you have that of the gorilla in miniature before you, any superiority of capacity however, belonging to macaque, for I find that, by adopting the method suggested by Professor Huxley, the *cranial capacity* of a macaque is 182, the basi-cranial axis being taken as 100. Examined in the same way, that of the gorilla, according to Professor Huxley, is 170 ; that of a baboon, 144 ; of a lemur, 119 ; of a beaver, 70. Of the *Bones of the face* of the gorilla, the *Upper Maxillary* differs greatly from that of man, but closely resembles that of macaque. In both gorilla and macaque it forms no part whatever of the front boundary of the nostrils, which is completed below and at the sides by the *Premaxillaries,* and above by the *Nasals.* In man, the lateral boundaries of the anterior opening of the *nostrils* are formed by the *upper maxillaries* alone. This specimen shows well the situation and connexion of the *premaxillaries*—that portion of the upper jaw which, separate in the fœtus, eventually becomes united to the rest of the bone, and supports the incisor teeth. The *Teeth* of the gorilla, although agreeing, like macaque, in number with those of man, present in other respects some most remarkable differences. I must call your attention not only to the skeleton of the male, in which the *canine* teeth are broken, but also to this cast of the head of a fine old male. Look at these *enormous canines* ; look at them, comparatively as large and *similarly grooved,* in this male macaque. Now turn to the female, and they are not more developed than the other teeth. Why is this ? The answer is, they are weapons of offence and defence, for neither the gorilla nor the macaque is a flesh-eater. Du Chaillu distinctly tells us that he never found other than vegetable food in its stomach ; but affirms that he had several times noticed skulls in which the large canines were broken off, not worn down. The negroes informed him that such teeth were broken in combats between the males for the possession of a female. Now, consider this subject well. These teeth are *formed* in the jaw *before birth* ; say at the sixth month of fœtal life their future form is sketched, and ere one year they begin to calcify or harden, and some years later, that is at or before puberty, they displace the milk or temporary set. On this subject, the arguments of Professor Owen as against the transmutation theory are so unanswerable that I will quote them. He says :—'The weapon is prepared prior to the development of the forces

by which it is to be wielded; it is therefore a structure pre-ordained, a predetermined character of gorilla, by which it is made physically superior to man, and one can as little conceive its development to be a result of external stimulus, or as being influenced by the muscular actions, as the development of the stomach, the testes, or the ovaria.' The *Præmolars* of gorilla and macaque differ equally from those of man, in having one fang more, besides that the crown of the first of the lower jaws is much larger than the crown of the second, and its face worn down by the action of the upper canine. Thus, then, we have sketched out a head, brutal in form, and, so far as its original segments are concerned, vastly removed from that of man. One last point I will notice as illustrating many that might be demonstrated, could we examine the interior of the brain-case. At the bottom of each *orbit* in man a *horizontal fissure* exists between the *oribito-* and *ali-sphenoids* for the transmission of motor and sensory nerves to the eye, and of sensory nerves to the forehead, nose, and eyelids. This fissure is usually formed into a foramen by the junction of the outer angle of the oribital plate of the *frontal*. I say usually, for I have seen the oribito- and ali-sphenoid meet, and convert it into a foramen. This, however, is very exceptional, so much so as not to be mentioned by Owen and most anatomists, not even by Ward, who has described more minutely than any other writer the characteristics of the human skeleton. It is very different, however, in gorilla and macaque. Instead of a wide fissure, *a square-shaped hole* is seen, resulting from the union of the *oribito-* and *ali-spenoids* close to their origin. It has further been pointed out by Owen, and may be seen in this skull of the macaque, that there are no *ridges* to the *alæ minores* defining the fossa for the anterior lobe from that for the middle lobe of the brain, as in man, *a short triangular plate* answering to the rudiments of the *alæ minores* and to the bases of the anterior clinoid processes, but not extending backwards, as in man. Such characters as these, and there are *many such* in the skull, by which both gorilla and macaque are distinguished from man, could never result from external causes; they are quite without the influence of muscular action, and are handed down from parent to offspring; and their importance may be judged of when we consider that the brain case is made for the brain, and not the brain for its case, and that all other parts of an animal's frame are brought into

harmony with this great seat of sensation and volition. The examination of the skull would then lead us to infer a great predominance of brutal instincts in the gorilla. How far does this agree with what is known of its habits? Du Chaillu says, 'I think the gorilla utterly untameable.' Of a young one in captivity, not yet three years old, two feet six inches high, and possessed, for its age, of most extraordinary strength and muscular development, he says: 'He sat in his corner looking wickedly out of his grey eyes, and I never saw a more morose or ill-tempered face than had this little beast. The second day he was fiercer than the first. He rushed savagely at anyone who stood, even for a moment, near his cage, and seemed ready to tear us all to pieces.' Further on—'I never saw so furious a beast in my life as he was. He darted at everyone who came near, bit the bamboos of the house, glared at us with venomous and sullen eyes, and in every motion showed a temper thoroughly wicked and malicious. As there was no change in this for two days thereafter but continual moroseness, I tried what starvation would do towards breaking his spirit. He always snarled at me, and only when hungry would he take the choicest food from my hands. Ten days after he was chained he died suddenly. To the last he continued utterly untameable.' Of the *Vertebræ*.—In the male there are *seven* in the cervical region, which are remarkable for their enormous spinous processes; in the dorsal *fourteen*, *i.e.* vertebræ articulated to movable ribs, *four* lumbar, and *five* sacral; in all, *thirty*. In the female there are *seven* cervical, *thirteen* dorsal or costal, *four* lumbar, and five sacral; in all, *twenty-nine*.—In man, *seven* cervical, *twelve* dorsal, *five* lumbar, and *five* sacral; in all, *twenty-nine*. There is a *great approach to man in the lower dorsal and upper lumbar vertebræ, at the same time that there is a great departure from macaque*. There are many points of great interest to the student in this region of the three skeletons before you, chiefly in the *mode* of *interarticulation*. Time will permit me of only thus alluding to them. Although there are usually only *twenty-nine* bones in these regions of the spinal column in man, we have a skeleton in the University Museum possessing *thirty*, the additional one being in the sacrum; the number of costal vertebræ are, however, only twelve. The *Sacrum* in the gorilla is much narrower and less curved than in man, affording a *very poor base of support* to the vertebræ above,

at the same time that the last two lumbar vertebræ are locked in between the iliac bones. The sacrum of the macaque is proportionally broader and more curved than that of the gorilla ; although tailless the sacral canal of the gorilla is more closed than in man. The *Pelvis* of the gorilla at first sight approaches the human in form ; the *ilia, or haunch bones,* are expanded and hollowed out on their inner surfaces, as in us ; but a closer inspection proves this part to be structurally and functionally very different. The ilium of the gorilla has no curved crest, as in man, nor are its surfaces alternately concave and convex as in him ; the outer surface, except quite posteriorly, is one large convexity, and all the spines are less distinct. Of the *Pubes.*—The *pecten* is very prominent, and is all that remains of the upper surface of the horizontal ramus ; the symphysis is much longer. Of the *Ischium.*—*The spines are absent, or quite rudimentary,* and the tuberosities everted, so that they project beyond the lower margins of the acetabula. The *obturator foramen* has its diameter passing from above downwards and inwards, in man downwards and outwards. There are many other points by which the pelvis of the gorilla approaches, in spite of these expanded haunch bones, that of the macaque, and inasmuch as he approaches macaque he recedes from man. I will not trouble the meeting with the measurements I have made of this part of the skeleton ; for the present, let me observe that this expanded portion or ilium is by far less important, physiologically speaking, than this lower portion, or *true pelvis,* which constitutes the passage through which the little stranger is brought into the world. Its *diameters* in the human species are therefore carefully studied, both by the accoucheur and physiologist, and one never ceases to admire how exactly its shape and size are adapted to the fœtal form. But in gorilla and macaque, as indeed in *quadrupeds,* the diameters of this cavity are the reverse of those in man, the *antero-posterior* of the inlet exceeding that of either the *oblique* or *transverse.* Moreover, there are no prominent *ischial spines,* as in man, so that the mechanism of parturition must be very different in man and gorilla, very similiar in gorilla and macaque. Time will not permit me to dilate as much I should wish upon this important part of the skeleton. Enough, however, has been said to show that it constitutes another great structural and fundamental distinction between the human species and the

gorilla, and all the quadrumana. Moreover, there is probably another great difference in this region between man and gorilla. I am informed by my friend and colleague, Professor M'Coy, that in the chimpanzee, by many supposed nearer to man than the gorilla is, a bone exists in the *penis*. I found one also in the penis of the macaque, and it is most likely one will be found in the gorilla, as the drawing of this organ in Professor Duvernoy's plates resembles that of the macaque. Nothing of the kind has ever been discovered in any variety of the human species. Now it is an universal law that no part of the body withers and dies out, unless from disease. Use and nutrition being the same, a part remains the same, and when we come to the question of descent, this is the very part of an animal that must have been used to have raised our question. What reason have we to believe that our old quadrumanous ancestor was less active in this matter than are the apes and monkeys of the present day? Those who, striving to uphold the doctrine of the transmutation of species, say that if not *of* the apes we may be *from*, should tell us how this bone has disappeared from man. This may be the place to say that the *young* gorilla, like the young of brutes in general, becomes sooner independent of its parents than the young of the human species. Little Joe, as Du Chaillu calls him, was not three years old; his height was two feet six inches. This is rather short for a child of the same age. Yet Du Chaillu was compelled, in order to bring him in, to take 'hold of the back of his neck, two men seizing his arms and another his legs; and thus held by four men, this extraordinary little creature still proved troublesome.' The *Scapula*, blade bone, has some points of resemblance to the human. It differs in the spine springing further from its posterior border, and making the *supra* and *infra-spinous fossæ* of more equal dimensions. It does not present, as in man, a generally concave surface for origin of the *subscapalaris*, but a median convexity towards the thorax. In this and in the following particulars, it approaches more the scapula of macaque, viz., a well-marked elongated excavation for the long head of the *triceps* muscle and part of *subscapalaris* and a proportionally larger *coracoid process*. The *Humerus*, both in man and macaque, is shorter than the *femur*, but in the gorilla it is much longer than the femur. Excepting its size, and the more prominent outer convexity of its inferior trochlear surface and the boundaries of the

olecranon fossa, it is more like the same bone in man than in macaque. The *Ulna* and *Radius* are more bowed and strongly marked for origin of muscles than in man. The *lesser sigmoid cavity* of the radius is, as in macaque, further removed from the shaft than in man. The Hand is of a large size, the *pisiform bone* and *phalanges* being greatly developed, the former for bending the wrist, the latter for grasping. *Upper Extremity.*—This really *imposing* part of the gorilla's skeleton differs widely in its uses from the upper extremity of man. Of the varied functions which the hand of man performs I need not speak. In the gorilla its chief use is for *grasping* and *progression*. It is in this latter he loses all resemblance to man and approaches the macaque. The excessive length of the arms enables him to walk as a quadruped, and more especially, by the enormous development of the *pectoral muscles* and by the peculiar attachments of the *lalissimus dorsi* and *dorso epitrochlearis* muscles, the latter not existing in man, but present in the macaque, to *draw his huge body after him*, as in *climbing*. Du Chaillu says: 'The skin on the back of the fingers, near the middle phalanx, is callous and very thick, which shows that the most usual mode of progression of the animal is on all-fours.' Again: 'The common walk of the gorilla is not on his hind legs, but on all-fours. In this posture the arms are so long that the head and breast are raised considerably, and as it runs the hind legs are brought far beneath the body. The leg and arm of the same side move together, which gives the beast a curious waddle. It can run at great speed.' The *Femur*, both in man and macaque, is longer than the humerus, but in the gorilla it is shorter. It differs in other most important respects from the same bone in man. Thus in man the femur has *two obliquities*, one of the *neck* and another of the *shaft*, whereby the lower extremity is approximated to its fellow, that the feet may be conveniently brought within the area of support. In the gorilla there is only an inclination of the *neck*, and none of the *shaft*, so that the lower end is as far from the median line of the skeleton as the upper or farther—a disposition favourable to a *quadrupedal*, but not to a *bipedal* walk In the proportionate size of the *trochanters*, it resembles more the femur of the macaque than of man. *The Leg.*—There is a curious similarity between the relative lengths of the leg and foot in both gorilla and macaque, by which they differ equally from man. Thus, the length of the *tibia* in man is 16 in., of the

foot 10 in. ; in gorilla, the *tibia* is 12½ in, the *foot* 12 in. ; in macaque, the *tibia* 4¾ in., *foot* 4½ in. *The Foot.*—The *Tarsus* presents the following points for observation : The *Os Calsis* is more slender than in man. The inner surface is more curved, the lesser process projects more inwardly, and both outer and under surfaces are more arched. The *Astragalus* is grooved both by the tendon of the *flexor longus pollicis*, and by that of the *flexor longus digitorum.* In man, it is grooved for the *flexor longus pollicis* alone. Passing by other points, which time will not allow of noticing, we arrive at the *Internal Cuneiform* bone, and here we see, as in macaque, a change in harmony with all that has gone before ; the surface which articulates with the great toe or hind thumb, as near as possibly resembles the surface of the *trapezium* which supports the thumb of man ; thus, putting the *fore arm* and *hand* in the same position as the *leg* and *foot*, I can describe the articulating surface of both the *internal cuneiform* bone and *trapezium* in nearly the same terms. And with reference to the median line of the skeleton, say that it looks inwards, and is partially concave from above downwards, convex from side to side, and supports a movable and opposable thumb. Such a description would not suit the corresponding bone in man. Finally, of the *Phalanges.*—Each corresponds in development with that of the *hand* of man, gorilla, and macaque, none agreeing with the corresponding toe of man. I have elsewhere shown that the muscles of these hind fingers and thumb agree with those of the hand, and not with those of the foot of man. The following table renders this clear. The letters prefixed to the numerals express the relative lengths of the digits, *a* being the longest, *b* the next, and *e* the shortest :—

MAN.

(No. 1.)

HAND.

MUSCLES OF.

e. First digit, opponens.
c. Second digit, abductor, adductor.
a. Third digit, two abductors.
b. Fourth digit, abductor, adductor.
d. Fifth digit, adductor, opponens.

(No. 2.)

FOOT.

MUSCLES OF.

b. First digit, transversus pedis.
a. Second digit, two abductors.
c. Third digit, abductor, adductor.
d. Fourth digit, abductor, adductor.
e. Fifth digit, adductor.

MONKEY.

(No. 3.)

HAND.

MUSCLES OF.

e. First digit, opponens.
c. Second digit, abductor, adductor.
a. Third digit, two abductors.
b. Fourth digit, abductor, adductor.
d. Fifth digit, adductor, opponens.

(No. 4.)

FOOT.

MUSCLES OF.

e. First digit, opponens.
c. Second digit, abductor, adductor.
a. Third digit, two abductors.
b. Fourth digit, abductor, adductor.
d. Fifth digit, adductor, opponens.

Tables Nos. 1, 3, and 4 *are alike*, so that if the digits of the hand of man be fingers, so must they be in both hand and foot of monkey, for 'things which are equal to the same are equal to one another.' No. 2, however stands *by itself* the foot of man. But I must tell you, gentlemen, that my views are not generally received. It is supposed I do not know these muscles when I see them. A reviewer in the *Lancet*, December 12, 1863, says that he has found the '*transversus pedis* muscle largely developed in *macacus rhesus*.' And further on, speaking of the *opponens pollicis*, he adds : 'So far as we have been able to ascertain, no author has hitherto described this muscle in the hinder extremity of any animal, and we have never ourselves been able to find any trace of it, though we have recently examined several monkeys with this special object in view.' Now, I should be very sorry to mislead this Society, but I affirm that the '*opponens pollicis*' exists in in *every macaque* I have examined, and that the '*transversus pedis*' does not ; and, moreover, all the muscles referred to in these tables have been most carefully examined, and their

existence confirmed, by my friend Dr. James Robertson, with whose permission this statement is now made. I have also demonstrated to Professor M'Coy the exact origin and insertion of these several muscles. The reviewer above alluded to disposes of me in the following manner: 'The tables given at page 14 have, at first sight, the convincing aspect of anything taking the form of a mathematical demonstration; but as the premises have been shown to be incorrect, it is needless to follow out the working of the problem.' *Now, I have shown you that the premises are true.* But is the foot of the gorilla as *prehensile* as such an arrangement of bones and muscles would imply? Du Chaillu, speaking of a young one, says: 'He would come sometimes quite readily, to eat out of my hand, but while I stood by him would suddenly put out his foot and grasp my leg. Several times he tore my pantaloons in this manner. Again speaking of another: 'Several times I had narrow escapes of a grip from her strong great toe.' Of the adult he says: 'The foot of the gorilla presents a great likeness to the foot of man.' In another place he has: 'The sole of the foot looks somewhat like a giant hand of immense power and grasp. The transverse wrinkles show the frequency and freedom of movement of the two joints of the great toe, proving that they have a power of grasp.* Of the *Erect Position* said to be assumed by the gorilla.—It will be as well first to glance at the human skeleton, and see what are the provisions there made for such an attitude. The *transverse vertical plane of the centre of gravity* of the human body passes through the *condyles of the occipital bone,* then through the alternately *curved spine* to the *joint* between the last *lumbar vertebra* and the *expanded sacrum*; continued downwards, it runs through the *heads of the thigh bones, knee joints,* and *ankle joints* to the *feet.* The *longitudinal vertical plane* must pass also along the *spine,* and the *horizontal plane of the centre of gravity* has been found by Weber to pass likewise through the same *lumbo-sacral articulation*; hence the erect attitude is natural to man. The skeleton of the gorilla is, as has been seen, not adapted to

* "The disposition of the hallux as a hind thumb with the concomitant modification of the tarsal bones, are as strongly marked in the Gorilla as in any lower Quadrumane, and the contrast between the foot-structures of the Gorilla and negro is as great."—*Prof. Owen, Trans. Zoolog. Soc.* vol. v. part iv. page 269.

such a position. The head is not balanced upon the top of the spine, but is upheld by large muscles attached to the enormous cervical spines. The spine is not more curved than that of an elephant, and the knee joints, except when the powerful and peculiar adductors, similar in macaque, are put in action, are too much separated for other than a quadrupedal walk. Of the erect position of the gorilla Du Chaillu says: 'His manner of approach gave me an opportunity to see with how much difficulty he supports himself in the erect posture. His short and slender legs are not able firmly to sustain the vast body. They totter beneath the weight, and the walk is a sort of waddle, in which the long arms are used, in a clumsy way, to balance the body, and keep up the ill-sustained equilibrium. Twice he sat down to roar, evidently not trusting himself to this exertion while standing.' Again: 'I have frequently observed the fact that the gorilla is not able to preserve himself for any considerable length of time in the erect attitude.' Old Andrew Battel says, speaking of the pongo, which was most likely the gorilla: 'He differeth not from man but in his legs; for they have no calfe. Hee goeth always upon his legs, and carrieth his hands clasped in the nape of his necke when he goeth upon the ground.' There seems to me some truth here, for this position of the arms, the head being thrown back, would greatly assist in raising and supporting his *enormous belly*. As to the occasional contradictions in all the descriptions of the habits of this animal it is not to be wondered at, seeing that, according to Mr. Ford, 'when he hears, sees, or scents a man, he immediately utters his characteristic cry, prepares for an attack, and always acts on the offensive.' I have thus brought before you as many of the chief points in the anatomy of the Gorilla as time and opportunity would permit. I am at a loss to comprehend what are *ordinal* characters, if those seen in the *skull, teeth, pelvis, organs of generation* and *of progression* are not—characters which, taken together, prove the gorilla as much one of the great natural group of *quadrumanous*, or, more correctly speaking, *cheiropodous* animals, as they separate him and them from Man. With so distinguished a naturalist present as Professor M'Coy, let us hope that additional light may be thrown upon this subject this evening"

Measurements of the Skeletons of the Male and Female Gorilla in the Victorian National Museum, for comparison with those given by M. DE CHAILLU, *at page 379 of his work on "Equatorial Africa."*

	M.	F.
LOWER JAW.	inch.	in.
Length of the inferior maxillary bone, from the inferior angle of the ramus to the canine tooth	5⅞	4⅞
Do. to the median line, measured around to a point between the middle incisors	7	5⅝
Perpendicular height of the ramus of the jaw	4¼	3⅝
Greatest breadth of do.	3⅛	2⅜
Length of alveolus (in a straight line of the teeth)	3⅝	3⅛
Width across the jaw from the outer margin of the last molars	2⅞	2⅜
Do. do. at the canine or bicuspids	2⅛	1⅞
UPPER JAW.		
Length of alveolus from the last molar to the canine	3⅜	3
Do. do. around to the median line	4½	4⅛
Breath across the jaw at the molars	2⅞	2¼
Do. do. at the extremities of canine	2⅞	2¼
SKULL.		
Diameter of nasal aperture	1½	1⅜
Distance from lower margin of do. to the margin of the eye socket	3	2¼
Width of the face, measured across the eyes to the outer margins of the lateral orbital ridges	5⅝	4⅝
Width of the face, measured at the molar protuberances	6⅞	5½
Depth of the eye-socket to the optic foramen	2⅝	2⅜
Greatest length of the face, measured in a straight line from the summit of the orbital ridge to the lowest point of the chin	7½	6½
Distance from the base of the nose to the top of the orbital ridge on the median line	3	2½
Distance from do. to the outer angle of do.	4¼	3⅛
Diameter of the foramen magnum or spinal opening	1¼	1⅛
Distance from the posterior margin of that opening to the lateral termination of the occipital crest	3⅛	2½
Transverse diameter of the base of the skull from the mastoid protuberances	6	4⅛
Length of the occipital crest on its summit	11	7¼
Greatest height of this crest, measured perpendicularly from the surface of the skull	1¼	⅜
Length of the median crest on the top of the skull	5⅞	—
Distance from the summit of the orbital ridge to the point of junction of the crests on the occiput	8	—
(Measured from the highest points of the orbital ridge and the occipital junction of the crests, a line will not touch the skull.)		

LENGTH OF SPINAL COLUMN.

Length of the cervical vertebræ	5⅛ ...	4
Length from the first dorsal vertebræ to extremity of the sacrum	25 ...	19
Total	30⅛ ...	23
Add for shrinkage of the intervertebral cartilages (nearly one-sixth of total length)	5½ ...	3¾
Total length of spine ...	35⅝ ..	26¾

MEASUREMENTS OF THORAX.

Length along the fourth rib, measured from the spine of its vertebra to the articulation with cartilage	13¾ ...	10
Greatest circumference at the level of the eighth rib	44½ ...	—
Length...	14 ...	—
Transverse diameter of apex	4⅝ ...	—
„ „ of base	14½ ...	—
Antero-posterior diameter of base	10 ...	—

PELVIS.

Greatest breadth of pelvis, from crests of the iliac bones	15⅝ ...	13⅞
Breadth of pelvis, measured outwardly and posteriorly from the same points as above	18¼ ...	15½
Height of pelvis (perpendicular measurement)	13½ ...	10¾
Diameters of pelvic strait: sacro-public, or antero-posterior	6¼ ...	5⅞
Diameters of pelvic strait: oblique	5¼ ..	5
Diameters of pelvic strait: bis-iliac, or transverse	5⅛ ...	5⅛

UPPER EXTREMITIES.

Greatest length of the scapula plate	9 ...	7
Length of the humerus to radial articulation	16½ ...	14½
Circumference of the humerus in the middle of its shaft	4⅛ ...	3¾
Do. at the distal articulation, measured around the condyles ...	9 ...	7
Length of radius (fore-arm)	13⅝ ...	11¼
Direct length of ulna	14⅜ ...	12⅛
Length measured on its outward curvature	15⅜ ...	12⅞

LOWER EXTREMITIES.

Length of femur, measured from the round ligament to the lateral margin of tibial articulation	13⅝ ...	11¼
Length measured from summit of the great tuberosity to the lateral margin of tibial articulation	14⅞ ...	11¾
Circumference of the neck of the femur	4⅛ ...	3¼
Greatest circumference of the femur around the two tuberosities	9¾ ...	7
Circumference of middle of the shaft	4⅜ ...	3½
Circumference at the knee, measured over the patella	11⅛ ...	7¾
Length of patella	1¾ ...	1⅛
Greatest length of tibia (perpendicular)	11⅜ ...	9½
Length of fibula from knee to ankle	10½ ...	8¾

THE FOOT.

Greatest length of os calcis	3½ ...	2⅜
Greatest length of right foot, measured on top from tibia to extremity of middle toe	9 ...	—
Do., do., left	8½ ...	7⅛

Length of bones of middle toe from os cuneiform to extremity of the toe...	$7\frac{3}{4}$ ...	6
Do., do., left...	$7\frac{1}{2}$ ...	—
Length of great toe from do., right side	$4\frac{5}{8}$ ...	$4\frac{1}{8}$
Do., do., left side...	— ...	4

THE HAND.

Length of the hand, from the carpal bones to the extremity of the middle finger	9 ...	$7\frac{1}{2}$
Length of thumb	4 ...	3

ART. IV.—*On the Discovery of Cretaceous Fossils in Australia.* By FREDERICK M'COY, Professor of Natural Science in the University of Melbourne, Government Palæontologist, and Director of the National Museum of Victoria, &c.

[Abstract.]

The author stated that he had recently received a small collection of geological specimens, obtained by Mr. Sutherland and Mr. David Carson, of Collins-street, Melbourne, on the surface of a run on the western bank of the Flinders river, at the base of Walker's Table Mountains, in lat. 21° 13′, long. 143°, and presented by those gentlemen to the collection of the National Museum. The matrix is an olive calcareo-argillaceous marl.

The specimens included, besides the vertebræ of a very large teleosteous fish, which it was not possible to determine without further parts, two distinct species of the well-known cretaceous genus *Inoceramus*, with very thick coarse fibrous shells, *Ammonites*, and a few other remains, which, taken together, enabled Professor M'Coy to announce for the first time with certainty the existence of the Cretaceous formations in Australia. Mr. Gregory doubtfully indicated cretaceous fossils in lat. 30° 15′, in his last paper to the Geological Society, but without any generic or specific recognition of fossils of that age. His materials were, unfortunately, sent home, instead of being kept for comparison in the local collections in this country, and they have not been described or definitely identified

with any cretaceous forms, by the officers of the Geological Society, in whose list they are quoted, not as cretaceous but only as mesozoic. Mr. Selwyn also alluded formerly to a specimen of an Echinide in flint, given to him as found in gravel in sinking a well at Prahran, near Melbourne, having been identified by Professor M'Coy as the European Cretaceous *Conulus albogalerus*. The author had also a flint *Ananchytes ovatus*, of the same age, given to him as found at Richmond, near Melbourne also ; but he considered both these specimens were unsatisfactory, as far as the proof of their having really belonged to any Australian stratum. The present collection of fossils, though small, indicated the existence of the Lower Chalk, as developed in England and Germany, and this discovery nearly fills up the great series of marine mesozoic formations supposed to be absent in Australia when Professor M'Coy left Europe, but most of which he had recognised from fossil evidence since his arrival in Victoria, and made known at a former meeting of this Society.

The following are the three most interesting of the new species of mollusca :—

Inoceramus Carsoni (M'Coy).

This is the most common of the bivalves. It has a coarsely fibrous shell, nearly a quarter of an inch thick, agreeing in size and shape almost exactly with the English *Inoceramus mytiloides* (Sow.) of the English chalk, from which it differs in having the hinge-line rather longer, the anterior end more pointed, and the superior posterior angle rather more obtuse. This species Professor M'Coy named in honour of the enthusiastic young geologist who brought it down.

Inoceramus Sutherlandi (M'Coy.)

This is the second most common fossil, and is a much larger and broader species than the *I. Carsoni* (M'Coy). The author had much pleasure in naming it after the other donor of the specimens, which were so painfully carried, from the remote point indicated, to the settled districts, on their saddles. This second species, in form, size, and concentric undulations of the surface, nearly agrees with the French and English common cretaceous *I. Cuvieri*, but is less curved at the ventral margin near the beak, and rather narrower and more acute at the anterior end.

Ammonites Flindersi (M'Coy).

Discoid moderately compressed; periphery narrow, obtusely rounded; whorls 4½, about one-fourth of the width of each exposed in an obtusely angular-edged, flat-sided umbilicus; surface crossed by obtuse sigmoid striæ, some of which are more prominent than the more numerous intervening ones; diameter, six inches; proportional thickness, 29-100th; width of last whorl, 49-100th; seven much divided lobes in the septa of each side, two of which are within the edge of the umbilicus.

This ammonite, in size, number, and involution of whorls, shape, markings, and septa, is so nearly identical with the very common *A. Beudanti* (Br.), of the French Lower Chalk, that, but for being slightly less compressed, and a slight difference in some of the septal lobes, it could scarcely be separated even as a variety. The specific name is given to call attention to the locality.

ART. V.—*On the Desirability of Establishing the Geographical and Ethnographical Section under Law* 60. By THOMAS E. RAWLINSON, ESQ., C.E.

[Read 4th September, 1865.]

Situate in a young community, which (in this quarter of the globe) occupies the position of advance guard, in the civilization of the nineteenth century, it appears to me to be almost unnecessary to advance any particular argument, to convince the members of this Society, of the great importance of collecting the ethno and geographical facts within their reach, for the purpose of rendering permanent, a knowledge of things which are passing away, and of giving wider and more rapid publicity to discoveries, which are now being, and have been made, relative to the character, form, and capabilities of our adopted country and its aboriginal races.

Assuming that the general principle (of the desirability of securing the above objects) is admitted, I will proceed to advert to the objects themselves, and why this Society especially should concern itself in the matter.

At the present time, our geographical knowledge of the interior and around the coasts of Australia is gradually widening, but it is neither so full, or authentic, in all cases,

as could be wished; but there is little doubt, there exists a large amount of what I may call "floating knowledge" of remote localities, which at present is lost to the community owing to the want of some channel of communication between the bushman and the public at large.

The ethnology of the country, is likewise, in a very imperfect state, although, in this instance also, it is comparatively well-known, that a large amount of native lore, relative to the dialects, manners, customs, and habitats of the Aboriginals, is in possession of the frontier settlers and others, such lore having been acquired during a long residence in this country, in close contiguity with the native tribes. In most cases, this knowledge serves but as a basis for conversation and anecdote, between the settlers and strangers visiting them, whilst from diffidence mostly, but no doubt also from some vague feeling, that such knowledge is of no particular value, it remains hidden from the world. To those who have spent much time with the frontier settlers, many instances will occur, of gentlemen having considerable knowledge of these matters, but diffident as to its value. I have at this time in my mind, the recollection of one gentlemen in particular, who is possessed of considerable information on these matters, but whom hitherto, I have failed to persuade to render such information in a permanent form, from doubt whether it may be of sufficient importance. I feel convinced that much of this diffidence will be overcome, and a motive furnished for the exertion of committing to writing facts already known, and be an inducement to acquire more, if it becomes known that this Society is actively moving in the matter, and prepared to receive such information on the various branches of the subject, tending to illustrate the moral and physical character of the Australian tribes.

In addition to such sources of private information, this Society possesses the requisite organization for prosecuting its researches, through channels and by agencies which are scarcely open to a private individual. I allude to the public officers and departments of the several colonies, through their respective Governments, who, I assume, would willingly render all possible assistance in the objects proposed if sought for by the Royal Society.

Lastly, that by diffusing information as to the exact nature of the facts required, and the objects to be served, a system of inquiry will be the result, and the gentlemen engaged,

having a definite object before them, will have a greater interest, and more zeal in the work.

The interesting paper in our last volume from the pen of Mr. Beveridge, on the Murray Natives, is a fair sample of the information possessed by the settlers and others, and there can, I think, be little doubt that by giving a judicious direction, and an object to the inquiries of such gentlemen, a very large amount of valuable information will be obtained by them, in addition to the facts already in their possession.

That such inquiries as those I now suggest, more especially in reference to ethnography, should be taken up without delay will admit of little debate, for it is well known that many of the native tribes are rapidly disappearing, and in all human probability in a few years, some of them will be extinct.

Such is virtually the case with the natives of Tasmania. Whilst in New South Wales and Victoria, and, I am informed, even so far north as Riverina, they are rapidly disappearing. The formerly numerous tribes of the Yarra Yarra, the Goulburn, Gipps Land, Geelong, and other parts of Victoria, have dwindled to a few scores, and those remaining, unless more fortunate than their brethren of Tasmania, must in a few years, like them, die out.

Under such circumstances it is high time that this, or some other kindred Society, should initiate the requisite steps for obtaining, and rendering in a permanent form, the most complete available records of the manners, customs, and dialects of the native tribes, together with such measurements and portions of the skeletons, which are necessary for comparison with each other, and with remoter nations.

Of the various tribal languages or dialects, the most copious vocabulary is desirable, of words referring to simple things of common use, not only for comparison with each other, but with those of the nations and tribes of other portions of the world, to assist in elucidating the problem of human affinities, and the original derivation of stock.

Some progress has already been made in this branch of science by explorers, and by ethnologists who have visited our coasts from time to time, but from the limited sources of information within reach of most of them, little more than the boundaries of such knowledge has been passed, and it yet remains as a reward, for the persistent efforts of some society, having the requisite organization and machinery, to eliminate full and complete information on these questions whilst such

information is obtainable, and it is to the performance of such a duty I now invite the members of this Society.

The manners and customs of the Aborigines, would necessarily be an accompaniment to any inquiry into their dialects, but with this difference, that much greater circumspection will be requisite to eliminate truth from fiction—actual well-established usage and faith (if any) from artifice and invention.

To the above general sketch of the information required, I may add, that the inquiries instituted will, in all likelihood, render possible the compilation of a map, showing the distribution of the various tribes, and may also throw some additional light on the peculiar productions of some of the less-known regions of the country.

For the accomplishment of the above objects I beg to propose the formation of Section E, for Geographical and Ethnological Science, under Law 60, and that Professor Halford, Mr. Gideon Lang, Mr. J. J. Stutzer, Mr. James Bonwick, and myself, be the first members, and that Professor Halford be the chairman of the section.

ART. VI.—*Probable Astronomical Causes of the Contortions in Palæozoic Strata, and the Prevailing Meridianal Strike of the Older Rocks of Victoria.* By THOMAS HARRISON.

[Read 16th October, 1865.]

At the very commencement of this paper, I would especially wish to disclaim aught like a desire to set up a theory. At the utmost I simply ask leave to read before your Society certain notes and observations which have occupied my attention for the past three or four years. I do even this interrogatively. I lay the various facts and reasonings before you as a humble seeker after truth, and not as one by whom truth has already been discovered.

To my mind there seems to be some show of reason in what will be advanced. That, however, will be for your Society to determine. Should I be so fortunate as to have, almost inadvertently, hit upon the solution of a geological difficulty, I am well assured all present will rejoice equally with myself. Or if, on the other hand, I have been pursuing a mere shadow, the sooner my eyes are open to the error, the

better will it be both for myself and all persons concerned. I assure you that when the thought first struck me I was just as much inclined to laugh at it as absurdity as will be the most sceptical of yourselves. It was only after facts had forced themselves upon my notice, time after time, that I mustered up sufficient courage to resolve upon my present step.

I was first led to the conclusion that other than mere local upheavals had determined the dip, strike, and contortion of the palæozoic strata, by a consideration of the rocks near Melbourne. I find that there, and indeed over the whole colony, the strike is nearly always meridianal, and the contortions of such a nature that they could not possibly have been caused by simply upheaving forces; a lateral pressure seeming to be absolutely required.

This lateral pressure, so universally demanded to explain geological phenomena, is not accounted for by any theories of cosmical action that I am aware of. Sir Henry De la Beche certainly suggests how it might be originated by the beds of strata becoming oxydized, thus occupying more space than in their pristine condition. He, however, appears to have forgotten that the same deposits must have been already in the form of oxides when first laid down.

But even this theory of a general expansion of the crust, together with that which supposes the interior of the earth to have contracted as the central heat diminished, fail to account for the singularly regular, even mathematically straight, direction of the general strike of Australian palæozoic strata.

Let us suppose the substance of an artificial globe to shrink independently of the paper covering, or an apple to shrivel in the interior while the rind remained of its original size. Wrinkles would occur in all directions, but such wrinkles would have but little regularity of arrangement, and aught like a parallellism of ridges or of depressions, extending over any wide space, could not possibly be looked for.

I know of no other theory so well accounting for the phenomenon—supposing it to be by any means general, and with few exceptions it seems, as regards palæozoic deposits, to be manifested over large tracts of the earth's surface—as an absolute change in the figure of the earth itself.

That the earth is spheroidal, and not spherical, we know from astronomical observations made with the greatest exactness. We know, too, that the spheroidity is just, or

nearly what it ought to be, by the theory of gravitating and centrifugal forces. If, then, the spheroidity is just what it should be from the earth's present rate of axial revolution, any greater rate of revolution in the past must necessarily have resulted in a less spherical form than that now obtaining.

I. Let us see what would be the result of any change in form such as the one suggested; that is, from a spheroid, the difference of whose diameters was excessive, to one in which the two diameters approximated to each other.

First. The equatorial diameter and circumference would be shortened, and as the dimensions of the crust or solid covering of the molten nucleus within would remain constant, a puckering in such crust would be the natural sequence. The force, also, causing these puckers, would be in the direction of the parallels of latitude, so that the corrugations (if I may so term them) would run in a strictly meridianal direction. This phenomenon of the puckers would be common over all tropical and semi-tropical regions, save in the exceptional cases to be presently mentioned.

Secondly. The polar diameter would be increased. Hence, at the arctic and antarctic circles, the molten matter within would tend to swell outwards, and as the same would act upon a rigid crust, such crust would be fractured in a stellar form, the rays proceeding from each pole as a centre.

Thirdly. Between these two regions of contrary disturbances would be one of quiescence. This region would correspond, or nearly so, with the temperate zone.

II. It is interesting to see whether marks of these supposed disturbances are anywhere apparent in the arrangement of strata, and other physical features of the earth's surface.

First. In Victoria, as was previously stated, the strike of the strata is, generally, nearly north and south. This strike seems to prevail over very large portions of the Continent.

Secondly. In a paper by Mr. Searles Wood, appearing in the *Philosophical Magazine*, this peculiarity of strike is stated to be incidental to palæozoic strata nearly all over the world; that is where such strata are at all contorted.

Thirdly. The principal mountain systems in which palæozoic rocks prevail run nearly north and south, as witness the Andes, the Rocky Mountains, the Ural, and the Australian Alps. Near the equator in Brazil, too, are numerous chains of mountains, all of which, by Johnson's

Map of the World, appear to have a meridianial direction. I see by the map in Murchison's Siluria that Silurian strata abound in that part of the Continent.

Fourthly. The trend of the land is generally north and south. This fact has been often noticed, but never satisfactorily accounted for.

Fifthly. The Andes diminish in altitude as they approach the south, as though the lateral pressure was there, as it were, dying out through an approach to the region of quiescence before alluded to. In New Zealand, lying much farther south than ourselves, the palæozoic strata are less distorted than in Victoria. In Russia, also, situate in the supposed northern region of quiescence, the Silurian strata are often, as I believe, found in a nearly horizontal position.

Sixthly. The northern and southern polar circles are either covered by drift or by ocean, so that the supposed stellar fractures are not observable.

III. It will be asked whether any force capable of diminishing the rate of the earth's axial revolution exists in nature.

1. Up to a very recent period the rate of the earth's diurnal revolution has been spoken of as constant. This conclusion, however, is doubted by eminent astronomers of the present day. *There is a retarding force.* The same being found in the resistance to the earth's axial revolution, resulting from the friction of the tidal wave, which, lagging a little behind the moon, impinges upon the shores of continents and islands, so that force becomes changed into heat, which is lost completely by being radiated into space.

The consequences of this force are apparent, in some few discrepancies discovered of late in certain astronomical tables.

2. There appears to me to be yet another source of retardation. Two deep water currents are continually running from the several poles to the equator. As these currents respectively pass from points whereat the axial velocity is nothing, to where it attains nearly one thousand miles per hour, the waters are left a little behind the earth, so that the currents really take a N.W. and S.W. direction, and, by impinging upon the easterly coasts of continental masses, must necessarily constitute a resisting power. There is, I know, a counter current, wherein the conditions are reversed, running from the equator to the poles; but from the evaporation in low being in excess of that in

high latitudes, the two currents are by no means equal in amount, so that the balance of force would go to retard the earth's motion.

These forces are, it must be admitted, most ridiculously small, but even an almost infinitesimal force, acting continually, must inevitably stop a motion, however swift, and put an end to a momentum, however great. There is no resource, therefore, but to conclude that these respective agencies—if you admit them—acting throughout countless ages, have tended, and are materially tending, to bring about an utter stoppage of our planet's axial revolution.

IV. There are some few astronomical facts relative to other planets of our system which may serve to throw still further light upon this subject.

The moon, which has no axial revolution, is quite spherical. Seen through a telescope, too, it presents a feature —for my own part I attach but little importance to the fact —yet, as bearing upon the present subject, the feature is rather remarkable. Near the satellite's upper limb is the great crater of Tycho, and from this as a centre run a number of radiating lines, corresponding with (supposing this crater to have been once the moon's pole, when she had an axial revolution like the other planets) the hypothetical star-like fissures at the north and south poles of this our earth. Adjacent to the space over which the rays extend is a region seemingly of quiescence, and beyond is what seems to me a zone in which a puckering up of the surface has taken place, analogous to that supposed in the tropical regions of our own globe. I lay but little stress upon this fact, and merely mention it in passing and by the way.

The surface of no other planet is thus open to telescopic inspection, but there are certain physical facts connected with several illustrative of the theory in a measure somewhat remarkable.

In the first place there is a very striking difference in the rate of their respective rates of axial revolution. Nearly all revolve in different times, and there is this peculiarity, that the slowest motions are just where the quickest ought to be expected, and *vice versa.*

Thus the Earth's period of axial revolution is twenty-four hours, but that of Jupiter, a much larger planet, is only twelve. Saturn, less than Jupiter, but an immense body as compared with the earth, is ten and a half hours. That of Mars (a planet whose diameter is half that of our own) is

twenty-four hours. The respective velocities and diameters of Venus and the Earth nearly correspond.

Now granting, for the sake of argument, what is by no means improbable, that all the planets had the same initial rate of axial velocity, and granting also that currental influences were in each, continually tending to bring about a stoppage, what was likely to happen would be nearly as follows :

Jupiter and Saturn being large bodies, would, notwithstanding these retarding forces, maintain their respective velocities for a lengthened period, just as a heavy fly-wheel acts as a more efficient reservoir of power, and runs longer, from the same impulse, than a light one. The motion of the earth as a small sphere would be speedily slackened, whilst the satellites (they being of diminutive size, and, moreover, subject to an inordinate amount of attraction from their respective planets) would soon come to a standstill, their axial revolution ceasing altogether.

Venus and Mars would seem to present an anomaly, since, having no satellites, they could have no lunar tides. The apparent anomaly, however, diminishes as examination proceeds. Venus would have a considerable solar tide, whilst the currents running from her poles to her equator must, from the intense heat to which the planet is subjected, be greatly in excess of those acting upon the earth. Mars, from its small size, might also have a considerable solar tide. There is, however, a difficulty with respect to this planet which I am utterly unable to explain away.

What, however, would go far to show that the axial velocities of the several planets are not constant, is the discrepancies manifest in the respective spheroidities of the bodies as compared with the rate of their diurnal revolutions. Taking the spheroidity of Jupiter to be what it ought to be from the tremendous velocity with which that orb revolves, that of Mars would be greatly in excess of the amount assignable to it by calculation. To my mind the cause of this lies in the fact that Jupiter, as a large body, and retaining its heat longer, is not yet completely solidified, or has only a proportionately thin crust, and is, therefore, sufficiently plastic to allow of gravitating forces acting at once, and as soon as they in any way preponderate over the centrifugal force, giving the planet spheroidity. Mars, however, being of much smaller dimensions, would soon lose its heat, and as soon grow rigid. From this cause the latter planet might

retain its pristine form long after the spheroidity of that form was greatly in excess of what it should be from the rate of axial revolution.

Venus, on the other hand, may have retained a large amount of original heat, not because of the vastness of her mass, but on account of radiation being checked by proximity to the Sun. She may, therefore, remain nearly as plastic from this cause as in the far off Jupiter from quite a different one. Hence she is even more spherical than the earth. If this hypothesis, however, be true, then the earth is even now somewhat more spheroidal than it should be—surmises as to this being the case have, I think, ere this engaged the attention of astronomers.

Granting that this theory be true, it will readily be seen how the changes spoken of are likely, not only to cause contortion of strata, but also to act upon and alter the mean temperature of the globe. It is pretty generally acknowledged that the average climate of a particular region is not wholly dependant upon the region's latitude. Islands enjoy a more equable temperature than does land thrown into large masses. It is inferred, therefore, that the relative amounts of heat, received at given times, from the sun may be identically the same, yet that two or more very different climates may prevail. Sir Charles Lyell's theory of climates is well known. "With all the land gathered round the poles," he argues, "we should experience a maximum of cold; with a preponderance of land at the equator, the reverse conditions would prevail." Geologically this theory is of great practical importance. Very many diverse climates have, at different times, prevailed upon the earth. Taking from the close of the Cretaceous age, we find that at the dawn of the Tertiary epoch tropical fruits grew in what is now England, and that a tropical fauna prevailed whilst our own Victorian Eocene beds were laid down. At a much later period England appears to have been submerged beneath an arctic sea; its mountains covered with glaciers, and its ocean dotted with icebergs. A little attention will show how these facts bear upon the hypothesis under consideration. As the rate of the earth's axial revolution diminished, the central molten nucleus would be the first portion losing its spheroidity. The rigid crust might, and would, retain its former shape for a lengthened period. There would thus be a hollow beneath the equator, and an increased pressure tending to cause disruptions at either pole; but for a time this state of

instability would continue. Meanwhile the waters would arrange themselves, not parallel with the spheroidal crust, but concentrically with the spherical mass within. Two large oceans would thus accumulate near the poles, thus uncovering the major part of the equatorial regions. Under this state of things the earth's climate would increase in temperature. Then, at last, as convulsions shattered the crust, or as the simple force of gravitation caused the arch at the equator to give way, and the pressure at the poles overcame the resistance confining the molten matter within, would the equilibrium be restored, water would again occupy the torrid zone, and some portion at least of the polar oceans would be left dry ground.

I do not, however, think that the restoration of equilibrium and exposure of the polar continents were the real causes of the intense cold incidental to the glacial epoch. The hypothetical hardly meet the real facts of the era, as made known by observation. On the other hand, high northern and southern latitudes appear to have been even more submerged than at present. A glacial climate might result from conditions somewhat the reverse of those described. That a vast tract of land in equatorial regions should cause a tropical climate to prevail in high latitudes it is necessary that such land should be of a low, or at least of a moderately low, level. Supposing an excess of land of great altitude, such as the land of the plateau of Mexico or of Thibet, to be gathered round the equatorial regions, a very different state of things would result. The equatorial regions might then be covered by perpetual snow from excess of altitude, just as are the plains of Nova Zembla by height of latitude. In such a case the southernly breezes of Europe would be as chilly as those coming from the north, simply that both would pass over equally frozen tracts of land. And this mass of high table land might very naturally be looked for under the conditions supposed.

In the midst of the arctic climate so caused we may imagine that the equilibrium is somewhat suddenly restored. Tremendous currents would rush over what are now temperate regions; ample cause, it would seem, to account for the glacial drift of both northern and southern hemispheres, and for a very extensive destruction of animal and vegetable forms. Could this be the moment of which the second verse of Genesis speaks: "*When* the earth was without form and void, and darkness was upon the face of the deep, and the

Spirit of God moved upon the face of the waters?" And can it be that, when "the fountains of the great deep were broken up" at the succeeding flood of Noah, the yet unstable crust of the earth sunk still further, thus, by suddenly changing the centre of gravity, inducing another rush of waters deluging the world?

It will be objected that, if the lessening of velocity necessary to produce the phenomena spoken of was ever manifested in the past, the same ought to be observable at the present time. Astronomical observations are now carried on with so much of precision that an almost infinitesimal increase or decrease in the rate of the earth's diurnal motion would soon be detected. An analogous objection was once urged against the Copernican system. It was said that if the earth really revolved around the Sun in an orbit many millions of miles in diameter, the difference of place on the part of the observer must, at two different periods of the year, give rise to a great apparent displacement of the fixed stars. The absence of parallax is, however, easily accounted for, taking into consideration the vast distances of the observed bodies. If, in astronomy, Sirius is so far removed that 180 millions of miles, the diameter of the earth's orbit, dwindles down to a point when viewed from that distant star, may not geology deal with times so inconceivably extended that any diminution in the earth's motion is not to be discovered, although sought after during observations extending over many centuries.

It will be objected also that the amount of contraction required to produce effects such as are witnessed in Victoria, for example, would be so vast that no diminution in the earth's rate of revolution would be likely to give rise to it. It will not, however, follow that this crumpling of beds extends completely round the earth in any one zone. Crumpling of the crust could only take place where the substratum was somewhat of a yielding nature. Take an arch composed of alternate blocks of granite and soft brick, and subject this arch to enormous pressure; it will be the bricks that will give way, whilst the blocks of granite will be totally unaffected by the forces brought to bear. If, over the outside of the whole arch there be pasted layers of paper, crumpling of these will occur on the compressible brick portions only, and will remain undisturbed above the harder granite. It may happen, therefore, that it is only in the continental and island masses where such disturbances

have taken place, and below the ocean strata may still lie horizontal as when first laid down.

It will be objected further, that the strike of palæozoic strata is not always meridianal. This, I think, is no more than might naturally be expected. The contortions of strata could only take place over such portions of the substratum as gave way under the gravitating pressure. If any of these yielding areas happened to run in a zig zag direction, like the course of the Andes, for example, the strike of the superincumbent rocks would be materially influenced. And, again, local disturbances, such as might be caused by volcanic action, may have materially tended to give certain local directions to the strike.

It must not be lost sight of, either, that if the earth is really formed of a thin crust covering a still molten centre, and if even this crust at one time existed in a molten state, there is no possible alternative but to suppose that, as the heated mass gradually lost heat, the whole would greatly contract. The result of such contraction would be somewhat to diminish the tendency to bulge out at the poles, to increase the puckers at the equator, to remove the regions of quiescence to higher and higher northern and southern latitudes, and, perhaps, a little to increase the complication of the various puckerings seen upon the earth's surface.

This idea of the earth contracting by loss of heat is by no means new, the only difficulty being an astronomical one, since any diminution in the earth's volume would result in an increased rate of diurnal revolution, and no such increase is to be detected by the nicest observations. But may it not happen that, just at the present moment, these two results balance each other? May not the acceleration consequent upon contraction be, at this time, exactly counteracted by the retardation arising from friction of the tidal wave and currental influence?

It will, perhaps, be objected, that the time requisite to bring about the observed changes in this manner would be immensely beyond the limits of all reasonable hypothesis. I am, however, not quite sure of that. Take the whole series of rocks, and, in imagination, run over the list, from the granite upwards to the last bed of tertiary deposits. In Victoria alone Mr. Selwyn calculates the Silurian rocks to be upwards of 35,000 feet (nearly seven miles) in thickness, and this is only a fraction of the great thickness of strata manifested in other parts of the world. Remember that a

vast proportion of this thickness was evidently deposited in the deep sea, where accumulation could only go on with extreme slowness; and remember, too, how long a time would be required to silt up our own Hobson's Bay, close to the shore, and of very inconsiderable depth. Or take another geological phenomenon, that of denudation. How long must it have taken for the most rapid currents, and the most boisterous seas, to have cut down and carried away that vast amount of strata which has evidently been removed all over the Australian continent. Not a few geologists have gone so far as to suggest whether the erosion of gorges and valleys in granitic mountain chains has not been the result of long continued atmospheric action alone. Grant this, and surely the objection raised upon the score of time must be abandoned.

I must again request that you will not look upon the present paper as an attempt to set up a theory. So far as I have had an opportunity of examining the rocks of this colony, they certainly, to my mind, appear to favour the suppositions herein advanced. It may happen, however, that observations made in other lands might have led me to very different conclusions. It is in order that I may supplement my own facts and observations with the facts and observations of other and more experienced geologists that, with the greatest diffidence, I lay this paper before your Society.

ART. VII.—*A Report on the Results of an Exhibition of Gems, both Victorian and Foreign, and Works in the Jewellers' Art, in both Gold and Silver, held in the Hall of the Royal Society of Victoria during the week ending the 6th May,* 1865. Drawn and presented to the Royal Society by the REV. J. J. BLEASDALE, D.D., the President for the current year, 1865.

TO THE COUNCIL AND THE MEMBERS OF THE ROYAL SOCIETY.

Gentlemen,—I have the honour to submit the following Report on the Exhibition of Gems and Jewellery, which originated in a suggestion of mine made some months ago in a short paper read before this Society, and which, under your auspices, has now been brought to a successful termination.

It affords me satisfaction to be able to state that the numerous and various exhibits were brought together into this hall, and returned to their respective owners, without loss or injury of any kind, and that the whole amount of injury done to any kind of property has not gone beyond the breakage of one pane of glass, and a single glass vial not thicker than a goose-quill. I mention this for the information and encouragement of exhibitors, should we ever need to invite their co-operation again in a similar project.

From all that I have been able to gather from the various sources through which public opinion is made known, I have reason to think that those who did the exhibition the honour of a visit went away not disappointed, but rather pleased, whether they were scientific mineralogists or amateurs.

In proposing and in carrying out, under your auspices, this exhibition, I had in view mainly three objects:

1. To bring together from the various gold and gem-producing districts of Victoria, not merely doubtful specimens, but the actual collections of scientific mineralogists and collectors, and the individual discoveries of parties of men employed in mining.

2. To afford a favourable opportunity to persons interested in the development of this neglected source of our mineral wealth, of seeing, in one general view, what Victoria is producing, in what I may call a desultory way, and by accident; and how far these productions will bear comparison with matters of a like nature found in other regions of the world; and also to enable myself to draw up complete catalogues of these various treasures, with a view to the diffusing of more general knowledge of precious stones among the mining population, and thereby inducing them to pay attention to them, and to institute a more uniform and systematic search for them.

3. To make more universally known the power and ability existing among us to elaborate and finish, in all their several departments of art, out of the precious metals with which our favoured country abounds, those works of skill and taste which have been hitherto generally considered the peculiar productions of the old world.

To aid in furthering these objects, fine specimens, both native and foreign, were assembled in this hall, and it is to be hoped not altogether without leaving behind a favourable impression of our own resources.

This Report, then, is intended to further these objects in

some degree; and to furnish a starting point for more extended information; which can alone be collected from local sources. And it is to be hoped that, for some time to come, lucky finders of gem stones will be so good as make their discoveries known, and that the local newspapers will open their columns to their communications, and circulate the information whenever obtained from reliable quarters.

Built as the hall is, with all its lights far over head, it afforded both ample wall space for cases, and at the same time every variety of light and shade that could be desired for the most perfect display of the gorgeous exhibits. Down the centre of the hall were the great cases, holding works of most exquisite finish, and beautiful designs in the precious metals—many the works of our own gold and silver smiths—and some into which *art* was introduced from other countries, for sake of comparison with our own.

Whatever may be the defects of the hall, certainly it is the only one of any considerable size in Victoria entirely suited for an exhibition such as this, or one of painting or sculpture. Its proportions, its wall space, and above all, the height of the windows, secure it this unique distinction.

There was no complaint of the paucity or common place nature of the exhibits; on the contrary; and, had it been deemed desirable, vast quantities more could have been introduced, and among them some magnificent things, *e. g.* large Colonial works in church plate, racing cups, &c.; but they were either declined or not asked for, owing to the difficulty of finding suitable and secure glass cases to protect and display them. This will be, perhaps, the proper place to thank many exhibitors, for their kindness in disturbing their business arrangements in order to supply cases, and especially the Board of Mines, from which, and from the Hon. the Commissioner of Mines and R. Brough Smyth, Esq., I have received the most cordial co-operation.

With the exception of one firm, I never met with a direct refusal to co-operate—but on the contrary, every assistance—whilst some went to both trouble and expense in preparing works specially for the occasion.

Having premised *thus* much, on the general arrangements and matters preliminary to the exhibition, I will now submit to you the substance of the results attained, and such reference to the catalogue of exhibits, which I have appended to this report, as may be useful or necessary for elucidation. As my special object was from the beginning to gather

together on one occasion, within these walls, as large an amount and variety of authenticated Colonial gem stones as possible, whether cut or in their natural state, I intend to devote the main portion of this report to that feature of the exhibition ; still, I trust I shall be able, either to-night or at the next meeting of our society, to do justice to the other half of the precious works in gold and silver which lent so much lustre and interest to the exhibition, both as works of art from the parent country and as displaying the peculiar excellence of our own Colonial workmanship. I will now, for the sake of method, invite your kind attention to a few observations on the gems and precious stones, which I propose to treat in the order in which mineralogists generally place them, commencing, of course, with that justly designated king of minerals the

DIAMOND.

So late as this time twelve months there was a certain amount of hesitation among our mineralogists to admit that the diamond *had been* found in Victoria, beyond the possibility of a doubt. Even my learned predecessor in this chair, Professor M'Coy, when noticing, in his annual address, a paper of mine, in which I had called attention to the subject, added, that "none of them had actually occurred to myself." And this was true. But I had the assurance of more than one truthful man of the fact, and I had examined personally the district which yielded them, and compared it with the geological descriptions of the diamond mines of Brazil and the Ural mountains, and found such evidences of identity as would have warranted me in saying that if none had been found a search for them ought to be instituted. The results of this exhibition have now placed this important truth far beyond impeachment, and have afforded the public an opportunity of seeing our own diamonds both in the rough, and cut and polished, in all their beauty.

The only locality from which I have *seen* the diamond is Beechworth, though I have been assured that one or more have been found near North East Gippsland. Taking the cautious and learned traveller and mineralogist Mawe as an authority, I may here express surprise that no diamond has been reported from Moonambel, Mountain Creek, or Mount Greenock, where the blue topaz occurs. Speaking of the beautiful blue topaz, he says, "It occurs along with chrysoberyl, in that conglomerate which we have already mentioned

as the repository of the diamond." It must be remembered that he mentions—and our own experience confirms it—that the formation in which the blue topaz occurs is quite different from that in which the yellow topaz is found. I am not aware that one yellow topaz has yet been found, while we have discovered blue ones equal to the finest known specimens from other countries. This leads me to point attention to the fact, well known in Brazil, that wherever the blue topaz is found there also the diamond may be looked for. Mr. Turner's collection, in which were some good small blue topazes from Beechworth, confirms the statement of Mawe.—It may not be out of place here to say that I look forward with some anxiety and much hope to the day when the labours of the geological department, so well and so carefully carried out in other districts, shall be extended to those where the diamond has been found. And if I might do so without offence, I would take this opportunity, while the interest raised by the late exhibition is still fresh in the minds of those most interested, to hint that the special examination of these districts about Beechworth should receive the earliest possible attention of the Geological Department; for it is not by individual labour, but only by the careful examinations of a staff from that department, so ably presided over by Mr. Selwyn, that we can expect finality in this direction. Modesty, perhaps, ought to make one abstain from mentioning individuals, and now I only speak of those I personally know, and I throw no imputation on others; but I do here deliberately take this opportunity of saying, that if my learned and amiable friend, Mr. Ulrich, of the Geological Survey, with his extensive experience and his love of crystals, were detailed off, with his assistants, for a few months, all the scientific mists now hanging over our most prolific gem-bearing district might not only be cleared up, but a flood of light thrown on the future prospects of Northern Victoria as a gem-producing country. What I am stating in this place will appear far more reasonable and striking when I come to animadvert upon the special collections of gems forwarded to the exhibition by Mr. Turner and Mr. Milner Stephen—collections made by them upon the very spots where they have been discovered, or picked out of heterogeneous masses of rubbish which miners brought to them for examination.*

* Catalogue—Turner, 6 uncut; Bates, 1 cut, large; Falk, 1 rough, in a ring; Stephen.

CORUNDUM—THE SAPPHIRES.

Of this important class of gem stones it seems to me that no one country in the world can boast of so large a variety. Whatever may be said of the perfection in size and colour of particular stones, it nevertheless does appear that in no known country has there been brought together so great a variety of sapphires; and if this can be said of the results of accidental discovery, surely something more might reasonably be expected had a systematic search been instituted. In reality we owe nearly all our knowledge to the circumstance of these crystals having persistently asserted their greater specific gravity, and having therefore clung to the gold till it came to the last operation of cleansing in the tin dish! What had been thrown away with the larger pebbles no man can tell; but it is the same in all nature, where you find small stones there are larger ones not far off.

Not altogether out of place, in a report like this, will be an anecdote related to me at least nine years ago, and before a single sapphire had been reported by the diggers, by my friend Mr. Crisp, of Queen-street. In the course of a conversation with him on such matters as I am now dealing with, I had asked him for any information he possessed, when he told me of several matters brought to him, and then added, "I have found but one sapphire, and that I got out of *the craw of a wild duck:* curiosity led me to examine the miscellaneous collection of stones in its gizzard, when I found a true dark blue sapphire." I never doubted the truth of this; but the exhibition brought out such an abundance of sapphires from *Dandenong Creek* as to render it rather a wonder that more have not been found under like circumstances, than that he should have discovered the one I now mention.

Of sapphires, then, the exhibition brought together satisfactory specimens of the following kinds and colours:—Indigo blue, pale azure, deeper azure, the *true* azure, the green or Oriental emerald, of which several specimens were very large and fine, and a few well cut by Mr. Spinck, of Melbourne, out of specimens supplied by myself and Mr. M. Stephen, now of Beechworth. There were also many specimens of the hair brown variety, the adamantine spar, quite a number of the asteriæ, the star sapphire, but all, save one, of a dark yellowish brown colour, but most perfect in their six-rayed star and their crystallographic characters. In my

collection, as well as that of Mr. Turner and Mr. M. Stephen, was a curious variety of the star sapphire, having a jet black fixed star of six rays, with a black centre, and a fine float of white light over the surface, as cut *en cabochon.* I exhibited several sapphires cut by Mr. Spink, of an opaque or slightly translucent character, which yielded the true character of a cat's eye—but again they differed from the onyx cat's eye, in being of a darkish peculiar colour. I also showed several in the rough. Uncut were a few long crystals of the yellow variety, the Oriental topaz, as also one or two crystals of the grayish-blue variety of the star sapphire. These were in Mr. Stephen's collection.

Of rubies we had only their representative, actually in the exhibition, an opaque, red corundum stone, described and named by Mr. Stephens—Barklyite—after our late governor, Sir Henry Barkly.

There is no doubt, however, that the true Oriental ruby was found by Mr. Ulrich, near Mount Eliza, on Port Phillip Bay. He assured me he had subjected it to every known test of its purity. I may mention that lately I saw a genuine specimen from New Zealand. Last year I exhibited a star-ruby, found in Queensland, and cut in Melbourne, the size of a small horse bean, and very fine both in colour and in the star it displayed.

Any of the above are admirably suited for ring-stones, either for ladies or gentlemen; and would certainly be much more becoming than the bits of blood-stone and carnelian, which are so generally worn by gentlemen now-a-days; while in the case of ladies' bijouterie, the real sapphire would be a vast improvement upon vinegar garnets, and either imitation or bad emeralds set with foil, and sure to be ruined the first time they are immersed in water.

TOPAZES.—COLOURS: WHITE, BLUE, AND PINKISH.

White topazes are very numerous, and of them we had some fine specimens from Beechworth, Gipps Land, and, remarkably, from Flinders' Island, in the Straits. This may be said of those from Flinders' Island, that they possess very great fire and beauty when cut, and are nearly all of a pale yellowish shade in the rough. There were plenty of blue ones from Beechworth, and some in my collection from near Talbot. But I had not any of the exceedingly large ones from the last-named locality, which attracted so much atten-

tion on the occasion of a conversazione, held in our Hall a year ago. They had passed into private hands, and could not be easily traced.

No yellow topaz has yet been found that I could ever hear of for certain. All those shown to me were quartz—the cairngorm stone.

I may add that the exhibition brought out nothing fresh as regards the crystallographic character of the white and blue topaz. It was in every instance obscure to the eye, such as presented by rolled pieces, or rather water-worn specimens; but those from Flinders' Island were more distinctly marked in their outline than their Victorian neighbours.

I may venture to say that there is not in the world a stone fit for brooches, of size, and fire, and lustre, and suited to both day and candle light, equal to some of the blue topazes which I have known to be found in Victoria. On former occasions I have brought under the notice of this society blue topazes, both cut and mounted, and in the rough state, of a quarter of a pound weight, perfect in colour, and, considering their great size, almost faultless. Most of these were from about Mount Greenock and Talbot.

ZIRCONS AND HYACINTHS.

The zircon family is most abundant over the gold regions of Victoria. I have seen them of several distinct colours and shades of colour.

In my own collection are a few remarkably beautiful crystals, and rolled lumps of a very dark red colour, and perfectly clear. I exhibited one or two small white ones, cut, but regret to say that I failed to discover the owner of one of great beauty, which I saw when cut by Mr. Spink, and said to have come from Gipps Land. It was free from the sombre tint, so often seen in the white zircon.

Of hyacinths there were in the exhibition a considerable number, both cut and in the rough, found in Ballaarat, near Daylesford, and the Crooked River. Along with the cut specimens I exhibited some fine ones from India, Indian cut, along side of which our own lost nothing in comparison. This gem is perhaps too much underrated, on account of its somewhat brick-red colour; but it must be remembered that it is a fine stone for artificial light, and free from the blackness which so detracts from the beauty of the garnet in any

but daylight. Since these gems are very abundant on nearly all the gold-fields, I cannot help thinking that if they were prized as they ought to be by the public, the lapidary would get over his dislike to them, and devise means for imparting to them their full measure of polish.

BERYLS.

It is uncertain whether any aquamarines have as yet been found in Victoria. I have a few in my collection, but I am wholly ignorant of the country from which they have been brought. Not unfrequently the pale blue topaz is mistaken for the aquamarine, but never if the hardness and specific gravity be attended to.

Lately, my reverend friend, W. B. Clarke, the eminent geologist and mineralogist of Sydney, has sent me a list of his discoveries, which I have appended to the catalogue of our exhibits; and in it he informs me that *he* found in some granite a fragment of true emerald. In working granite quarries these most valuable gems may be at any time discovered.

Perhaps the next in order as gems are the OPALS. Of these we have beautiful specimens of the true *noble* opal, found at Beechworth. I saw three specimens in the hands of diggers, more than two years ago, at Beechworth, which were of great size—quite an inch long—much water-worn.

I exhibited perhaps the finest *fire* opal yet found in Victoria, which I obtained from a digger at Beechworth, and got cut and polished by Mr. Spink. This particularly fine stone, one part of which was cut off for a specimen, attracted the curiosity of the curious in these matters, for its size and beauty; and more than one of the learned exhibited ill-disguised feelings of disbelief on the first day's exhibition. But when the fine collection of Victorian gem-stones arrived from my learned friend, G. Milner Stephen, Esq., now of Beechworth, containing a specimen of this gem, of his own finding, my feelings of gratification may be understood. The *fire* opal, when of good size, is everywhere justly esteemed as a fine stone. Among the Geological Department's exhibits was a fine lump of opal, from South Australia, found by our most able director of the geological survey.

Now, this "fire opal" connects our mineralogy with that of Mexico and Brodbo in Greenland.

Our garnets are, without exception, of the most precious almandine tint, and fine in size and clearness. The exhibition contained quite a number, both cut and in the rough. I have not yet seen one red garnet, such as are found about Mount Vesuvius.

THE QUARTZ ORDER.

The exhibition brought together a vast variety of specimens of this class, both wrought and in the rough, and embracing nearly, if not quite, every known colour. Smoky quartz and cairngorms, as they are called, were in great abundance, as also pure white crystals, and water-worn lumps, and amethysts of every shade of purple, but falling somewhat short in colour, when compared with the best of those of Ceylon and Siberia. These stones occur all over the colony, but have been mostly found where digging for gold is carried on. Among the exhibits of Mr. Turner, of Beechworth, were a number of exceeding beauty and size, exquisitely cut, and tastefully set as brooches and ladies' ornaments.

Chalcedony, chrysoprase, and agates, in great variety, came up from Beechworth, chiefly from the Woolshed Creek and Sebastopol.

TOURMALINES.

The specimens of this stone, found in the granite from the Ovens district, were mostly opaque. The only *clear* crystal that I remember in the exhibition, that was undoubtedly Victorian, was one in my collection, found by myself in granite rubbish close to a bridge, between Benalla and Wangaratta. I thought I had found a specimen in the granite used for the foundation of Sandhurst Gaol, but am not quite sure of it. I call attention to this matter here, for the purpose of interesting some one in keeping an eye to such matters when working the quarries from which that stone was obtained, near Sandhurst. The large concretions of many different substances here and there visible in it was suggestive of other matters besides tourmaline, such as beryl, the emerald, garnets, &c.

In my collection was a dark-green tourmaline, step-cut, of rather more than three carats, which would compare favourably with many emeralds of the same size. This stone

improves in artificial light. The yellow light suits the somewhat bluish-green, and raises it to almost perfect grass green. If this stone proves to be abundant in Victoria, it will soon be a favourite, and bring a good price.

PEARLS.

The exhibition brought together a few samples. Mr. C. D'Oyley H. Aplin, of the geological survey, showed a few from Port Essington; but their 'orient' was not good. Three or four, found in the river Yarra Yarra, were decidedly better, both in form, lustre, and colour.

Whether the true pearl oyster has been found about our shores or bays, I am unable to state. I was informed that these stones were found in a variety of the mussel.

No gem was so sparingly represented in the exhibition, whether by native or foreign specimens, as the pearls. Mr. M'Farlane, of Elizabeth-street, and the Messrs. Davis Brothers, were almost the only ones who sent any Oriental pearls.

PRECIOUS STONES.

We may here very properly draw a broad distinction between gems and *precious* stones. Every gem is a precious stone, but not *vice versâ*.

For the purpose of clearness in this report, they have been separated, mainly, though not solely, by their opacity.

Of this latter kind the exhibition showed a brilliant collection of beautifully cut specimens of malachites, agates from Cooper's Creek and the Ovens, ribbon jasper, and blood stones. These were so exposed as to be readily compared with wrought specimens from Scotland, Egypt, Ceylon, India, Germany, &c. They were mostly cut for brooch stones.

I must now refer to the detailed account of the gem-stones furnished by Geo. Milner Stephen, Esq., as found in the catalogue hereto appended. I feel sure that he will forgive me for saying, that I consider him the most diligent collector, the most enthusiastic labourer in this department that I know, scarcely excepting even my friend, Mr. Ulrich. These matters appear to have been the leading passion of his life—the indication of his peculiar genius. And his fine collections—by far the finest of any private individual in this part

of the world—are evidence of his intelligence and persevering assiduity during half a life time.

I have heard that his collection has been offered to the Government at some price vastly beneath its real value—for it is almost impossible to fix a price on a collection which has been prosecuted under favourable circumstances during very many years. And I take this opportunity of using any weight which can be conceived to attach to my opinion, to say that if the mining department possessed such a collection, it would be of infinite value in the development of our gem treasures—to have them for the purpose of sending specimens, or duplicates, to the athenæums and mechanics' institutes, or other similar public bodies, to serve as standards of comparison with specimens found on the spot. To the man of science such a collection may be of comparatively little use, for he can take his own ways of determining any given gem or mineral; but the miner, the 'digger'—the instrument which the colony has now to use for the collection of these valuable matters—is not a man of science; but for the present, a man who can use his senses, and who, when he has *seen* a thing, can suppose that another which falls under his observation is identical, or similar in appearance; pick it up and reserve it for further inquiry. Good though it may be in its own way, it is not enough to tell a miner, that if he has found something that he knows nothing of, he can have it examined by sending it to Melbourne. The 'digger' is not generally a man who will take that trouble; but if he can get at a specimen near at hand, he will compare his own discovery with it in a leisure hour at night, and then, if he has a doubt remaining, send it for an ultimate examination and report.

It has probably already occurred to you that I have more than once mentioned in this report gems that were known to be Colonial, which I had procured and brought before the society on former occasions, but which were not in our exhibition. I allude to them for the purpose of making this report, and the catalogues appended, somewhat interesting to persons outside our society, into whose hands this paper may happen to fall. And I must now claim your patience for a few moments, while I read to you some matters, which I may call "*results*" of the exhibition, because they confirm some portions of our Victorian discoveries, and because they add materially to our lists of colonial gem-stones. And when I state that it is to the kindness of the Rev. W. B. Clarke,

of Sydney, that I owe the communication, and that he himself has verified every item in his statement, I trust I shall not be considered as travelling out of my legitimate limits in allowing him to speak for himself of the products of New South Wales. He writes: "Now, as to the gems in New South Wales, they are no doubt numerous, but are chiefly confined to the gold-fields. In my book on the southern gold-fields I have appended two notes, in which you will see mention of some that I had met with at the time of publication. I sent you a copy of the book a few days since. Lately we have had found more diamonds about the same locality, Suttor's Bar on the Macquarie River. None of them are of considerable size. Sapphires red and blue, both dark and light coloured (I have also seen the *star* ruby), and topaz are very common, and some of the latter are of large size, but water-worn. Almandine garnet is not uncommon. The common garnet is abundant."

"Chrysolite is very common. Chrysoberyl has also been found; and near Cooma, in granite, I once found a fragment of an emerald. *All* the varieties of quartz have been found, including amethyst.

"In the Uralea River, New England, the amount of sapphire and ruby is enormous. The diggings there are in granite detritus, over granite and under basalt.

"We have *tin* crystals and water-worn corundum in abundance. I have seen a *blue tourmaline*, also epidote proper; and the magnesian variety also occur here. Among other things in this way I have procured very beautiful 12 dodecahedral crystals of gold. Zircon, hyacinth, &c., have also been found by me."

This list informs us that some very fine stones have been found, at least in their substance, whatever may be their individual value as gems, in New South Wales, and in the southern gold-fields. Chrysolite, chrysoberyl, and the star ruby are all valuable, and the last-named one is probably beyond all price, as compared with gold, if it be found of considerable size and strength of colour. All the recognised beauty of the ruby is enhanced by the grand chatoyant play of light, and the peculiar beauty of the six-rayed star.

We have here to deal with a class of men who are, for the present, in Egyptian darkness on all these matters; and we must bear in mind that the readiest way to enlighten men is to place under their eyes standards of comparison, and those well authenticated. The late exhibition showed clearly

enough how ready that class was to avail themselves of any means of obtaining information. Nothing pleased me so much, while it was going on, as to see the hardy miners, note-book in hand, taking an account of what they saw.

Among the many complimentary notices which appeared at the time, hardly one struck me as so effective, and true to what I witnessed, as that in our facetious weekly, *Punch*, in which two 'disgusted diggers' are pourtrayed, one saying to his mate, "*Well, Tom, if those are diamonds, strikes me we've thrown away a fortin in our time.*" Had the intelligent men I allude to seen diamonds—say only one or two—in the place where they were working I think they would have kept a brighter look-out for what fell under their observation. And what is said of the diamond holds good of other precious stones.

A glance at the catalogue of Mr. Turner's exhibits will satisfy any man as to the care and intelligence he has brought to bear on Colonial gems. When I was in Beechworth, two years ago, he most kindly gave me all the information which he possessed at the time, and went with me carefully over his collection. It was among some small stones of his that I found the first specimen of a curious kind of sapphire—a long hexagonal opaque crystal, with a chatoyant lustre across the long axis. This he kindly gave me; and on my return to Melbourne I got Mr. Spink to polish the ends, and I then found that I was right in my conjecture that it was one of the star sapphires. As it was a long crystal, and as its peculiar structure was shown only at the ends of the long axis, and through the long axis, I had it cut in two, and returned one of the pieces to him. This piece, mounted as an elegant ring, was in the exhibition, and the other half was in my collection. It has a distinct black six-rayed star, in a dark blue ground, and the centre, where the rays meet, is black. Over this is the customary opalescent float of white light. The intelligent reader of this report will do well to peruse the catalogue of Mr. Turner's gems. I would, however, call attention to one substance, as I have seen nothing like it before. Mr. Turner described it as a *wax opal.* It was a fine large lump, beautifully transparent, and of a deep wine-yellow colour. I think this ought to be examined more carefully, and the half of it cut and polished, that we may obtain some information of its value as a gem. I have seen nothing that resembles it in shape and apparent weight except some pieces of obsidian; but all the obsidian

I have seen here has been either blackish or greenish, whereas this is a fine clear deep yellow.

I avail myself of this opportunity to thank Mr. Falk, jeweller, of Beechworth, for the information he afforded me when there, and for his unsolicited kindness in sending us a few most valuable exhibits of Colonial gems. The rough crystal of diamond in my collection, mounted as a ring stone, was his. While conversing with him, and examining some specimens of noble opal the property of a digger—and which I much regret I could not obtain for the exhibition—a digger gave me the exceedingly fine fire opal which I exhibited as a ring stone, together with the piece cut off and kept as a specimen.

Mr. Spink's contribution of specimens and samples of his own cutting was very interesting, in both points of view. It was extensive, especially in agates, jaspers, malachite, and topaz. It was the largest and finest known specimen of colonial green sapphire, but it was in uncut.

While speaking of Mr. Spink's exhibits, I may with propriety say a few words specially concerning gems. Mineralogists love crystals; and hardly on any account can they be induced to cut and polish them. Now may I be allowed to say that I too love crystals; but my object is not the mere crystal, but the cut and polished crystal; to ascertain what it is worth as a wrought gem; what it may ultimately bring as a price in the market. My object, then, is first scientific, certainly; but secondly, interesting in a pecuniary point of view. The miner, whom we have to look to as our collector, cares little about the replacement of the angles of the gem stone, but a good deal about what it will fetch when sold in a fair market. Moreover, it must be remembered that there is not the shadow of a chance of mining being carried on for the sole or chief purpose of discovering gem stones; they must continue to be accidental discoveries, or holiday amusements; but still, a deal may be done in these ways, and by children, when we can once make them understand what certain rough-looking things can be converted into by the beautiful art of which Mr. Spink is a master.

Before concluding this report, I must claim your patience while I invite attention to a few considerations which naturally arise out of what I have already brought under your notice concerning the gem treasures of this our adopted country. The long list of gems and precious stones already discovered and brought together in this hall suggests some

interesting reflections, which carry the mind beyond the limits of Australia, and unite us with the most remote quarters of the globe. We have here, then, the peculiarities of India and South America displayed in our diamond mines. The blue sapphires take us to Ceylon and the East Indies. The green sapphire is a distinctive mark of Siam, and yet we have shown Victorian specimens equal to any known. The star sapphires have, perhaps, never been found in any other country save Ceylon, while some of its varieties found here seem altogether new. The ruby is almost peculiar to Ceylon and Pegu, and now to Victoria, Queensland, and some parts of New Zealand. The topazes of Victoria—blue, white, and pink—connect us in mineralogy with Brazil, Ceylon, India, North America. Whether the pink topaz be a genuine formation, or only a brown one altered by heat, this is not the place for discussing; but certain it is, that pink topazes have been found in our mines and cut by our lapidaries, while neither a brown nor a yellow topaz has yet been discovered. *Adhuc sub judice lis est.*

Perhaps no country in the world has excelled Victoria in the size, perfection, and beauty, of the blue and white topaz. And when they are comparatively so abundant and so cheap in their cut state, and so beautiful as ornaments, am I wrong in speaking in the most unmeasured language of contempt of the trumpery materials mounted in colonial gold in questionable taste, and imposed on the ignorant public for the genuine products of our mines, and the result of the skill of our lapidaries?

Catalogue of Gems, in their natural state, found and collected by George Milner Stephen, Esq., *Fellow of the Geological Societies of London, Germany, and Cornwall, Natural History Society of Dresden, &c., &c.*

1 (2) Diamonds (the larger exceeding 1 carat), found with 11 others in Finn's Claim. District, *Ovens.*
2 (2) Barkly-ite rubies (red corundum). *Ovens.*
3 (2) White sapphires (in hexagonal crystals, one having blue terminal planes). *Ovens.*
4 (1) Yellow sapphire (in purple hexagonal crystal, a rare specimen). *Ovens.*
5 (4) Dark blue sapphires. *Ovens.*
6 A green star sapphire (rare). *Ovens.*
7 A blue and white sapphire (in hexagonal crystal). *Ovens.*

8 (2) Large blue sapphires (one being green across the axis). *Ovens.*
9 A star sapphire. *Ovens.*
10 A fine dark blue sapphire (in hexagonal crystal). *Ballarat.*
11 A green sapphire (showing pearly reflections). *Ovens.*
12 A Barkly-ite ruby (red corundum). *Ovens.*
13 Fine green sapphire, weight 17⅞ carats, being a fragment of large sapphire measuring 1¾ inches across the prism, now in Mr. Milner Stephen's cabinet. *Jim Crow Creek.*
14 (2) Small blue sapphires. *Fryer's Creek.*
15 (4) Pale blue topazes. *Ovens.*
16 (3) White topazes (water-worn). *Ovens.*
17 A very large blue topaz, weighing 1 oz. 10 dwts. (water-worn). *Dunolly.*
18 A blue topaz (showing the "striæ" along the prism). *Upper Yarra.*
19 Large white topaz (water worn). *Ovens.*
20 (9) Essonites (orange-yellow garnets). *Ovens.*
21 (24) Almandine garnets (fine colour). *Ovens.*
22 (4) Do. do. (in icosi-tetrahedral crystals). *Ovens.*
23 (4) Blood-red garnets (pyropes). *Ovens.*
24 (6) Large precious garnets. *Ovens.*
25 (7) Almandine garnets (fine colour). *Ballarat.*
26 (15) Common garnets (in dodecahedral crystals). *Ovens.*
27 (2) Pieces of granite, containing almandine garnets. *Ovens.*
28 (9) Blood-red garnets (pyropes). *Ballarat.*
29 (2) Brilliant amethysts (in hexagonal crystals). *Ovens.*
30 (8) Colophonites (wine-yellow garnets). *Ovens.*
31 (3) Black spinelles (automalites). *Ballarat.*
32 (8) Do. do. *Ovens.*
33 (4) Deep red hyacinths (zircons). *Ovens.*
34 (2) Violet spinelles, or almandine rubies (one an octahedral crystal). *Ovens.*
35 (11) Deep red hyacinths (zircons.) *Ballarat.*
36 (100) Small do do. *Daylesford.*
37 A fire opal. *Ovens.*
38 (4) Black tourmalines, in striated prisms. *Ovens.*
39 Quartz crystal (with both terminal planes). *Ovens.*
40 Quartz crystal (cut). *Mount Alexander.*
41 Darling-ite (species of lydian or touchstone). *Ovens.*
42 A star ruby, showing lines of structure in hexagons. *Ceylon.* (Supposed to be a unique specimen.)

Memo.—I have mislaid a black centred star sapphire, and a beautiful compound crystal of red spinelle or balas ruby (which I found amongst some tin ore). *Ovens.*—G.M.S.

Exhibited by Mr. Turner, of Beechworth.

1 (2) Petrifaction agates, gold mounted as brooches. *Woolsheds.*
2 (5) Cairn gorm stones, gold mounted as brooches. Different colours; smoky and yellow; good quality. *Woolshed, Beechworth.*
3 Sapphire, mounted as a ring. *Ovens.*
4 Star sapphire, mounted as a ring. *Eldorado, Ovens.*
5 White topaz, mounted as a ring. *Woolshed, Ovens.*
6 Diamond, uncut, mounted as a ring. *Woolshed.*
7 (5) Diamonds. 2 octohedrons, 2 convex octohedrons, and 1 elongated convex octohedron. *Woolshed and Eldorado.*
8 (3) Smoky quartz. *Woolshed.*
9 (2) Yellow quartz. *Woolshed.*
10 (3) Geodes (water stones). *Spring Creek, Beechworth.*
11 (2) Barkly-ite. *Woolshed.*
12 (8) Petrifaction agates. *Reid's Creek.*
13 Agates, striped.
14 (5) Lydia stones. *Woolshed.*
15 Wax opal. *Near Beechworth.*
16 (2) Barkly-ite. *Near Woolshed.*
17 Banded jasper. *Beechworth.*
18 Plumbago and granite. *Woolshed, Beechworth.*
19 (2) Tourmalines; 1 large crystal, 1 fibrous.

Exhibited by Mr. Sullivan, Bourke-street.

1 Amethystine crystals on agate.
2 Quartz crystals on rose chalcedony.
3 Quartzose crystals, embedded in a mass of crystallized quartz.
4 Nodule of crystallized quartz.
5 Pebbles of jasper, of various tints.
6 Smoky quartz, crystals embedded in granite; a fine large specimen.
7 Wax opal. *Near Beechworth.*
8 (60) Blue and white topazes *Near Beechworth.*
9 Amethysts, 2; Barkly-ite, 4; tourmalines, chalcedony, jacinths. (Small specimens in a box.)

Exhibited by Mr. Mills, Richmond.

1 (6) Malachite. *South Australia.*
2 (3) Do. *Russia.*
3 Carnelian, fine red beads; 12 large, 6 small.
Do. variegated, red and pink; 15 beads.
Do. yellow, 9 beads.
Do. white, 18 beads

4 Red cut beads ; carnelian, 7 ; yellow and pink beads, 31.
5 (40) Coral, Sea of Tripoli ; pink coral, cut for buttons.
6 (2) Branch coral. Brooch piece, 1 ; fine pink beads, 2.
7 Blood stone (Buchana-Persia), very fine specimens. Cut and polished, 5 ; rough do., 1.
8 Mass of agate. *Egypt.*
9 (5) Onyx. *North India.*
10 Agate, sards (very fine). Beads, 15 ; sealstones, 6 ; rough, 1.
11 (21) Jasper, green and red. *Egypt.*
12 (2) Adulazia or moon stone. 1 large and fine.
13 Oriental amethyst, engraved. *Siberia.*
14 (24) Small Oriental rubies. *Pegu.*
15 (7) Small Oriental onyx. *North India.*
16 Chalcedonyx. *North Persia.*
17 Aventurine, composition.
18 (3) Chrysophase. *Silesia.*
19 Seed pearls. *Persian Gulf.*
20 Muppul, seed pearl, Scotch oyster.
21 (3) Amber.
22 (3) Pink shell, carved ornaments.
23 (2) Pearl shell, engraved, fine.
24 (5) Crystals, fine, cut.
25 Lydia stone, fine. *Turkey.*

Exhibited by Mr. Charles McFarlane, Elizabeth-street, Melbourne.

(In a large case.)

1 Onyx. *Bohemia.*
2 (9) Amethysts (purple). *Saxony.*
3 (12) Do. small, uncut.
4 Amethyst, very large, do.
5 (10) Aqua marines, cut.
6 (4) Do. white cut crystals.
7 (10) Yellow crystals, cut for rings, seals, &c.
8 (4) Rich brown crystals, cut.
9 Pink topaz, Brazilian, cut specimen.
10 Carbuncle garnets, 1 large and five small specimens.
11 (3) Riband jasper (1 cut, 2 rough).
12 (4) Moss agates ; (3) carnelians.
13 Agates, brooch stones. Various specimens, 7 ; slit specimens, 2. (In small case.)
14 (48) Amethysts, red and yellow.
15 White crystal, 1 uncut, 4 cut specimens.
16 Lapis l'Azuli. *Persia.*
17 (13) Roman Mosaics.
18 Malachite. *South Australia.*

19 Tourquoises. *Bokhara.*
20 Asbestos, 1 ; cameo shell, 1 ; enamel painting, Virgin and Child, 1 specimen.
21 (3) Pearls. *River Yarra Yarra.*
22 (3) Blood stones. *Siberia.*
23 (12) Garnets, cut and carbuncle.
24 (7) Aqua marines.
25 (13) Striped onyx, ring stones. *Germany.*
26 (39) Carnelian, red and white, seal and ring stones.
27 (18) Blood stones, cut for rings and seals.
28 Pearl brooch, Persian seed (plain).
29 Jacinth. *Ceylon.*
30 (2) Crysolites.

Exhibited by Mr. Spink, Collins-street.

1 (15) Malachite. Brooch stone ; a leaf do. ; set of buttons, 6 ; set of sleeve studs, 9. *Burra Burra.*
2 (3) Fine yellow amethysts, brooch stones.
3 Crystal quartz. Yellow brooch stones, 5 ; smoky do., 2. *Ovens.*
4 (3) Crystal quartz. Brooch stone, seal do., and triangle ; finely cut. *Brazil.*
5 Amethysts. *Ovens.*
6 (2) Zircons, cut. *Ovens.*
7 (2) Smoky quartz, cut. *Scotland.*
8 (2) White crystals, brooch stones, cut.
9 White topaz. 1 uncut, 2 cut. *Flinders Island.*
10 (4) Agate, sleeve buttons. *Cooper's Creek.*
11 Agate. *Ovens.*
12 (3) Agates. *Scotland.*
13 Jasper. *Egypt.*
14 Jasper. *Surinam.*
15 Jasper. *India.*
16 (2) Jaspers. *Scotland.*
17 (2) Agates. *Germany.*
18 Agate. *India.*
19 (2) Agates. *Queensland.*
20 (3) Smoky quartz. *Ovens.*
21 (3) Quartz bearing gold. *Tarrengower.*
22 (2) Crystals, part polished. *Ovens.*
23 (2) Brazilian topazes, fine specimens.
24 Lapis l'Azuli, fine slab. *Persia.*
25 Granite, forming an obelisk. *Gabo Island.*
26 Jade. *New Zealand.*
27 (2) Smoky quartz crystals.

28 (2) Slit pieces crystal.
29 (2) Crystal, partly cut.
30 (2) Hyacinths.
31 Green sapphire, fine large specimen. *Gipps Land.*

Exhibited by Mr. Vasey Symons.

1 Precious garnet. *Bohemia.*
2 Precious beryl. *Siberia.*
3 Ore of uranium. *Europe.*
4 Columbite, Kangaraslusk. *Greenland.*
5 Vanadiate of lead, very rare. *Chili.*
6 Dioptæs (silicate of copper). *Kirgis Steppe.*
7 Smoky quartz. *Mourne Mountains (Ireland).*
8 Crystalline quartz. *Cornwall.*
9 Amethysts. *Glen Rose (Ireland.)*
10 Amethysts. *Bay of Fundy.*
11 Emerald in matrix. *Santa fe de Bogota.*
12 Emeralds. *Santa fe de Bogota (Peru).*
13 Rock crystal. *Brazil.*
14 Quartz stalactite. *Derbyshire.*
15 Rose quartz. *Bohemia.*
16 Chalcedony. *Transylvannia.*
17 Riband galena. *Derbyshire.*
18 Yellow topaz. *Brazil.*
19 Topaz (various kinds). *Europe.*
20 Sulphide of silver. *Transylvannia.*
21 Topaz. *Schechenstein.*
22 Green quartz. *Dauphiné.*
23 Cupreous, silicate of zinc. *Caldbuck Fell.*
24 Beryl topaz. *Mourne Mountains (Ireland).*
25 Precious opal. *Hungary.*
26 Amethysts. *Glen Rose (Ireland).*
27 Topaz. *Brazil.*
28 Pebbles. Red striped, black and white agates. *Channel Coast of England.*

Exhibited by C. D'Oyley H. Aplin, Esq

1 Diamond, natural state. *Brazil.*
2 Star sapphire. *Ceylon.*
3 Blue sapphire. *Beechworth.*
4 Zircon. *Daylesford.*
5 Quartz crystals. *Cornwall.*
6 Spinell ruby. *Ceylon.*

7 Green sapphire. *Blue Mountain Diggings, Daylesford.*
8 Topaz. *Brazil.*
9 Precious opal. *Mexico.*
10 Pearls. *Port Essington.*
11 Cinnamon stone. *Ceylon.*
12 Corundum, red. *India.*
13 Moon stone.
14 Amethyst, quartz crystal. *Beechworth.*
15 Beryl, unknown. *W. Russia.*
16 Garnets. *Scotland.*

Exhibited by Geological Survey Department.

1 Gold in crystal of quartz.
2 Red opaque corundum, Barkly-ite. *Beechworth.*
3 Sapphires. *Dandenong Creek.*
4 Opal. *South Australia.*
5 Nodules of chalcedony. *Victoria.*
6 Chloro-bromide silver. *St. Arnaud.*
7 Beryl in granite. *S. Australia.*

Exhibited by Mr. Cederberg, Gold Embosser and Engraver, Queen-street, Melbourne.

1 A pair of gold embossed sleeve studs, representing aboriginal natives, kangaroo and emu, in raised gold.
2 An embossing on gold plate, executed by punching from the back and front, representing a copy of Murillo's picture of "Boys Eating Fruit."

Exhibited by Dr. Brownless, Vice-Chancellor of the University of Melbourne.

1 A steel tobacco box, elaborately engraved in devices all over.
2 A plum pudding stone snuff box, gold mountings.
3 A large silver tray or salver, being a testimonial.
4 A large candelabrum, of silver.
5 A black carnelian, surrounded with rose diamonds, mounted as a ring; antique pattern.
6 An antique signet ring.

Exhibited by the Rev. Dr. Bleasdale.

1 A fine large emerald, mounted as a ring. *New Granada.*
2 A fine large yellow topaz, mounted as a ring. *Brazil.*
3 A fine large pink topaz, mounted as a ring. *Brazil.*
4 A fine Oriental amethyst, mounted as a ring. *Siberia.*
5 A fine fire opal, mounted as a ring. *Beechworth.*
6 A fine sapphire star stone, mounted as a ring.
7 (2) Onyx cats eyes. *Ceylon.*
8 (3) Star sapphires, asterias. *Ceylon.*
9 Emerald. *New Granada.*
10 (5) Green sapphires. *Near Daylesford.*
11 Fire opal. *Beechworth.*
12 (4) Moon stones. *Ceylon.*
13 Tourmaline crystal. *Ceylon.*
14 Tourmaline, cut. *Ceylon.*
15 (3) Aqua marines.
16 (2) Zircons. 1 rough, 1 cut.
17 (5) Zircons, with crystals.
18 (4) Garnets, rough. *Gipps Land.*
19 (8) White topaz. Rough pebbles, 3; cut specimens, 3; slit only, 2. *Victoria.*
20 Rough sapphires. *Beechworth and Gipps Land.*
21 Crystals, rough specimens.
22 Jasper, blood stone. *Victoria.*
23 Blue sapphire. *Gipps Land.*
24 (3) Hair brown sapphires. *Beechworth.*
25 (3) Yellow amethysts, fine cut. *Beechworth.*
26 (3) Yellow amethysts, fine cut. *Brazil.*
27 Amethyst, purple.
28 (6) Garnets, red and brown. *Europe.*
29 (3) Yellow topaz. *Saxony.*
30 (4) Agates, various.
31 Carnelian.
32 Amethyst, purple, rough.
33 Amethyst, almandine garnets.
34 Star sapphires.
35 Emerald half-hoop ring.

Exhibited by Mr. Falk, Beechworth.

1 Yellow topaz, in brooch, gold mounted. *Beechworth.*
2 Diamond, in ring. *Beechworth.*

Exhibited by Mr. Anderson, Preston.

1 Crystal quartz, gold mounted. 1 pin and 2 rings.

Exhibited by J. B. Were, Esq., per Mr. Cederberg.

1 Crystal quartz, cut and mounted in gold as pin. Quartz from the "Age of Progress Mine," *Wood's Point.*
2 Labrador felspar, cut monkey's head, ruby eyes. Gold mounted as breast pin.

Exhibited by Mr. J. B. Humffray.

1 Crystalized gold. "Kuboid Quartz Mining Company," *Ballarat.*
2 Crystalized gold. *Ballarat.*
3 Copper from the "Thomson River Copper Mining Company's Claim," *Gipps Land.*

Stones exhibited by Messrs. Walsh.

1 Blue topazes.
2 Yellow amethysts. *Saxony.*
3 Tourquoises. *Northern Asia.*
4 (2) Yellow amethysts, brooch stones. *Brazil.*
5 (9) Purple amethysts. Yellow do., 6 ; white do., 2.
6 (5) Lapis Lazuli, ring stones. *Persia.*
7 (2) Blood stones, cut. *Buchara.*
8 Carnelians. White, red, yellow.
9 (6) Garnets, cut. *Bohemia, &c.*
10 (3) Cat's eyes. *Ceylon.*

Loose Stones, exhibited by Messrs. Denis Brothers, Bourke-street, Melbourne.

1 Sapphire, large. *Ceylon.*
2 Sapphires. Fine stone, small. *Ceylon.*
3 (6) Emeralds, large and good quality. *New Granada.*
4 Ruby, fine specimen. *Pegu.*
5 (17) Rose diamonds, various sizes.
6 (26) Turquoises. *Kiva and Bokhara.*
7 Garnets, almandine. *Pegu, Asia, and Europe.*
8 Yellow amethysts, seal stones. 1 triangle and 1 yellow.
9 Purple amethyst, brooch stone. *Europe.*
10 Yellow amethyst, cut stone.
11 (2) White quartz crystals, cut.
12 Emeralds. Small cut, medium quality. *New Granada.*
13 (6) Shell cameos. Subjects carved, unmounted.

Exhibited by the Royal Society.

1 Blood stone, in the rough ; a large specimen. *Northern Asia.*
2 Petrifaction of wood.
3 Crystals embedded in chalcedony.
4 Agate, yellow.
5 (2) Wax medallions.
6 Specimens of agates, jaspers, &c. *Cape Otway, Australia.*

Exhibited by Gordon and Gotch.

1 Bituminous schist, from which kerosene oil is now manufactured. *Little Hartley, New South Wales.*

Note.—It closely resembles the Boghead coal, or Forbane Hill mineral.

Exhibited by Mr. Matthew Watershom.

1 Specimens of secretions from blue-stone quarries, Riddell's Creek ; between Riddell's Creek Station and Gisborne.

Exhibited by Dr. Barker.

1 Manufactured by the late Dr. Ludwig Becker, an obelisk, composed of stones and medals of Australian production.

Exhibited by Mr. J. W. Thompson.

1 Gold digger's cup. Manufactured by Mr. Edwards.
2 An emu egg, mounted as a vase on a gold base, ornamented with models of digger's tools and machines, supported on two vines, the cup being embraced by vine leaves and tendrils, with bunches of grapes pendant. The cover capped with gold, surmounted by an emu. All mounted and lined with gold. Gold shield name-plate. Weight, 24 ounces of Beechworth fine gold.

Exhibited by Mr. Younston.

1 Quartz triangular seal, gold mounted.
2 Fine specimen of pale yellow quartz. *Gipps Land.*

Exhibited by Messrs. Denis Brothers, of Bourke-street, Melbourne.

1 Cameo brooches, gold mounted (Roman cameos). Subjects, heads.
2 (2) Gold brooch and earrings (diamonds and emeralds).
3 Gold brooch and earrings, with pearls and turquoise.
4 Gold brooch and earrings, with turquoises.
5 Gold brooch, with drop diamond and emeralds.
6 Gold brooch, with lapell of emerald and pearls.
7 Gold brooch, flower and leaf, with a diamond.
8 Opal and brilliant pin.
9 Ruby and brilliant pin (horse shoe).
10 Amethyst and diamond pin.
11 Gold locket, enamelled (diamond, cypher).
12 (5) Brilliant cluster rings.
13 (4) Brilliant half-hoops.
14 Large emerald and brilliant, cluster rings.
15 Smaller emerald and brilliant ring.
16 (2) Single stone brilliant rings.
17 Brilliant top earrings. 2 pairs.
18 Pearl and enamel earrings. 3 pairs.
19 Ruby and pearl earrings. 1 pair.
20 Emerald and pearl earrings. 1 pair.
21 Opal and pearl earrings. 1 pair.
22 Amethyst and pearls. 1 pair earrings.
23 Gold and emeralds. 1 pair.
24 Crystal, with ruby and pearls. 1 pair.
25 (3) Emu eggs, silver mounted.
26 (2) Flower vases.
27 Enamel painted tray.

Exhibited by Mr. Powell, of Stephen-street.

1 Fine gold ornament. Composed of a cow with diamond eyes, beneath a tree, with gold birds above. Golden grass and foliage, &c. (14 ounces.)

Exhibited by ———

1 Onyx ring. The property of the late Count John Dembinski.

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1 Cameo portrait of the late Sir B. Brodie. Modelled by Miss Kelly, of Beechworth.

Exhibited by Mr. George Crisp, Queen-street, Melbourne.

1 A very fine large emerald, mounted as a ring.
2 A superb brooch, consisting of a butterfly of fine brilliants and enamel, playing over a branch of the vine, with a bunch of large fine pearls arranged as grapes.
3 Gold brooch of florentine mosaic. Subject, a dove on a branch, with cherries.
4 Gold brooch of florentine mosaic, with red roses and other flowers.
5 Gold brooch of florentine mosaic. Subject, white rose and other flowers.
6 Gold neck chains. Three different patterns, of excellent workmanship.
7 A fine brilliant and ruby half-hoop ring, consisting of 3 brilliants of fine quality, and 2 rubies of fine colour.
8 An emerald and two brilliants, of fine quality, in a ring.
9 An emerald and brilliant ring, smaller, of the finest quality.
10 Two large loose emeralds, fine colour.
11 A large cameo head, mounted as a brooch, the cameo very fine.
12 A small cameo, as pin.
13 A gold and enamel locket, of superior workmanship.
14 A gold and enamel handkerchief ring.
15 A magnificent suite, consisting of—

1. Large bracelet, mounted with gold stems and ivy leaves, set with elmondine garnets.
2. A brooch "en suite."
3. A pair of earrings "en suite."

The whole of excellent design and finest quality. Materials, gold and jewels.

16 A silver mounted glass jug, oxydised silver. An aboriginal piercing an opossum with a spear, forming the design. Elaborately finished.
17 A diamond (perfect octohedron) fine specimen. *Borneo.*

Exhibited by Mr. James Murray, Bourke-street, Melbourne.

1 A gold brooch, with cut crystal quartz. *Wood's Point.*
2 Large brilliant, the largest found in Victoria, mounted as brooch. *Worragy, near Beechworth.*
3 Sapphire and gold brooch. *Beechworth.*
4 Sapphire, rough. *Beechworth.*
5 Crystal of quartz. *Wood's Point.*

Exhibited by Mr. Edwards, Collins-street, Melbourne.

1 Rose water dish and jug, richly embossed with roses and flowers, tendrils and vine leaves.
2 Prize Challenge Cup, given by the Volunteers in the Government Printing Office as a prize.
3 A superb claret jug, with a vine leaf wreath embossed round the body of frosted silver. The whole of the silver produced at St. Arnaud's mine.
4 A burnished silver chalice, Gothic pattern, mounted with malachite and other stones.
5 An elegant silver inkstand, Grecian pattern, engraved and chased. Purely Greek ornamentation.
6 Emu eggs, mounted in silver as vase, richly embossed and pierced.
7 Emu egg, mounted in silver as Grecian vase.
8 Emu egg, mounted in silver as a jewel-case, reposing on tree ferns, with native Australians and dog at the base: delicate ornament round the body, leaves, bunches of grapes, and parrots. On the top of the case are emus, in native fern, on which are placed a monkey, owl, and hawk.
9 A large cut glass claret jug, mounted in silver, with wreath of vine leaves, grapes, and tendrils, frosted and burnished; also burnished lid and medallions.
10 Cup formed of emu egg, mounted in silver, ornamental border, pedestal of vine stalk, with vine leaves and tendrils on a rocky base.
11 Cup formed of an emu egg, plain burnished base and pedestal, frosted moulding round the edge.

The whole of the above articles are manufactured of silver from "St. Arnaud's Silver Mine," Ballarat district.

Exhibited by Messrs. Walsh, Jewellers and Silversmiths, Collins-street, Melbourne.

1 A silver gilt racing cup, embossed and chased, surmounted with model of racer and jockey, frosted silver.
2 A silver gilt tankard, wreath of silver around, cluster of leaves for summit.
3 A silver gilt vase, frosted silver wreaths of vine leaves around body, neck, and handle, with pendants of bunches of grapes.
4 A silver gilt claret jug, frosted handle, wreaths of vine leaves, tendrils, and bunches of grapes pendant.
5 A handsome silver gilt mug, with cover (matted and moulded).

6 An engraved glass water caraffe, silver gilt, handle and neck.
7 Two silver gilt cups, egg shaped, arabesque work.
8 Two silver gilt cups, arabesque work, large size.
9 Two silver gilt cups, quite plain, silver gilt, frosted silver pillars and bases.
10 Four silver gilt mugs, arabesque work.
11 Two silver gilt mugs, engraved and embossed.
12 Large mug, silver gilt, large arabesque pattern.
13 A silver gilt bason and spoon, engraved, &c.
14 A large waiter, silver gilt, engraved with a bold ornamental border, frosted.
15 A waiter, silver gilt, smaller, of same pattern.
16 A silver gilt waiter, handsomely engraved, chased and beaded edge.

Exhibited by Mr. Evett, Gold Beater.

1 Specimens of gold leaf, and the method of beating gold into leaf gold; its various stages, together with the tools used in the trade.

Exhibited by Mr. Ford, Elizabeth-street.

1 Fine large specimen of crystalized gold.
2 A fine specimen of crystalized gold, triangular shape.
3 Silver (chloro-bromide) in matrix. *St. Arnaud, Ballarat.*
4 Crystals of boron.

PROCEEDINGS.

PROCEEDINGS.

ROYAL SOCIETY OF VICTORIA.

Session 1865.

MINUTES OF PROCEEDINGS.

ANNIVERSARY MEETING

Held in the Hall of the Society 13th March, 1865, to Elect Office-Bearers for the current year.

The Rev. Dr. Bleasdale, Vice-President, in the chair.

The following gentlemen were elected :—

President :

The Rev. J. J. Bleasdale, D.D.

Vice-Presidents :

R. L. J. Ellery, Esq. C. W. Ligar, Esq.

Treasurer :

A. K. Smith, Esq.

Secretary :

T. E. Rawlinson, Esq.

Librarian :

J. J. Stutzer, Esq.

Custos of Collection :

W. H. Archer, Esq.

Members of Council to Fill Vacancies :

Wm. Gilbee, Esq. Professor M'Coy. Jos. Bosisto, Esq.
E. Barker, Esq. Thos. Reed, Esq. Geo. Lewis, Esq.
T. H. Rawlings, Esq.

A vote of thanks to Professor M'Coy, for his valuable services during the past session, and a vote of thanks to R. L. J. Ellery, Esq., and the other officers of the Society, was unanimously passed.

(Signed) JOHN J. BLEASDALE, D.D.

4th May, 1865.

4th May, 1865.

EXTRAORDINARY MEETING.

Rev. J. J. Bleasdale, D.D., President, in the chair.

The following gentlemen having been duly nominated, were balloted for and declared duly elected Members of the Society :—

Howard Spensley, Esq.
F. W. Haddon, Esq.
Hugh George, Esq.
J. E. Neild, Esq., M.D.

A ballot was taken for the election of a Member of Council, *vice* T. E. Rawlinson, Esq., elected Secretary.

The Hon. D. Wilkie, M.D., was declared duly elected.

The following contributions were announced :—Addenda to the 1st, 2nd, 3rd, and 4th volumes, and Index and Title-page to Vol. IV. of "Fragmenta Phytographiæ Australiæ," by Dr. F. Mueller. "Meteorological Observations in South Australia," by Charles Todd, Esq., F.R.A.S. "Proceedings of the Royal Geographical Society of London," Nos. 4, 5, and 6 of Vol. VIII., and No. 1 of Vol. IX., by the Society. Address of the President of the Linnean Society for 1863 and 1864, Proceedings Nos. 25, 26, 27, and 28 of Vol. VII., and of 29 and 30, by the Society. "Transactions of the Botanical Society," Part 1, Vol. VIII., by the Society. "Erster Jahres berieght des Vereins für Erdkunde Dresden," by the Society. Transactions of the Royal Society of Arts, Vol. VI., Part 4, by the Society.

The President read his Inaugural Address, at the conclusion of which, the ladies and gentlemen present were invited to inspect the collection of gems and jewellery on the tables and cases, around the Hall.

(Signed) ROBT. J. L. ELLERY, Chairman.

23nd May, 1865.

22nd May, 1865.

ORDINARY MEETING.

R. L. J. Ellery, Esq., Vice-President, in the chair.

The names of the following gentlemen were read as candidates for lection as Ordinary Members at the next Ordinary Meeting :—

O. R. Campbell, Esq.
S. C. Dixon, Esq.

The following contributions were announced :—Cedar Wood for two specimen cases—by H. W. Alcock, Esq. "Northern Australia Geographically and Geologically Considered," by the Rev. Julian E. T. Woods, of Penola. Plants Indigenous to the Colony of Australia—by Dr. F. Mueller. Lychnophora Martins—by Carl

Henrick Schultz. "Bipontius Abhandlungen ders dem Geniete der Naturwissenschaftlichen Verein in Hamburgh," and "Jahresbericht der Pollichia eines Naturwissenschaftlichen Verein der Rheinfoltz"—by the Society, per Dr. Mueller. "On the Yarra Yarra Flood Commisioners' Report," by Robert Adams, Esq., C.E. "Transactions of the Academy of Science, Munich," 14 vols—by the Society. Two quarter sheets of the "Geological Survey"—by A. R. C. Selwyn, Esq.

By permission, Dr. Mueller called the attention of members to the exertions now being made by a Ladies' Committee in Victoria, to procure traces of the lamented explorer, Leichardt, and earnestly sought the aid and sympathy of the members of the Royal Society in the undertaking.

Mr. Thomas Harrison read a paper, "Victoria as a Field for Geologists."

Professor M'Coy discussed the statements put forth objectively, and the discussion was carried on by Messrs. Bonwick, Ellery, and others, on the various theories of quartz formations, &c.

(Signed) John J. Bleasdale, D.D.

12th June, 1865.

12th June, 1865.

Ordinary Meeting.

The Rev. J. J. Bleasdale, D.D., President, in the chair.

In accordance with Law XXIV., on the recommendation of an absolute majority of the Council, Dr. Von Schultz, of Deidesheim, Bavaria, President of the Polichia Society, and Professor Von Martins, Secretary to Academy of Science, Munich, were proposed as Honorary Members.

The gentlemen proposed at the last Meeting were balloted for and admitted.

The following gentlemen were nominated as Life Members, in virtue of Law XXVII. :—

Joseph Bosisto, Esq.
Jonathan B. Were, Esq.

To fill a vacancy in the Council caused by the resignation of Mr. Thos. Reed, James Bonwick, Esq., was proposed, seconded, and elected.

The following contribution was announced:—"Notice of the Life and Writings of Carl Christian Ross," by Laurent Etienne Borring—received through the Danish Consul, J. B. Were, Esq.

The President read his report on the Gem Exhibition.

Professor M'Coy briefly noticed some of the chief features of the report, and in reference to the diamond more particularly, commented

on its chemical and geological relations to the material with which it is frequently associated, and to its mineralogical characteristics.

The Hon. Secretary drew the attention of members to the necessity of proceeding with the publication of the Society's Transactions.

(Signed) John J. Bleasdale, D.D.

3rd July.

3rd July, 1865.

Ordinary Meeting.

The Rev. J. J. Bleasdale, D.D., President, in the chair.

The gentlemen proposed at the last Meeting as Honorary Members were balloted for and declared duly elected.

The gentlemen proposed at the last Meeting as Life Members were balloted for and declared duly elected.

The following gentlemen were nominated as candidates for membership, to be balloted for at next Ordinary Meeting :—

Geo. Pearce Ivey, Esq., F.S.S.
Jas. Flanner, Esq.
Gideon S. Lang, Esq.
E. J. Nicholls, Esq.
Edward Wild, Esq.
— Pegus, Esq.

In accordance with Law XXVII., Mr. John Flanagan was nominated for a Life Membership.

The Hon. Secretary announced that presentation copies of Vol. VI. had been presented to the Patron, Sir C. H. Darling; to the ex-Presidents, Sir Henry Barkly, and Professor M'Coy; and the President, Dr. Bleasdale; and that His Excellency had been pleased to undertake the presentation of copies to Her Majesty the Queen, and to the Emperor of France, and that copies had also been forwarded to the Honorary Members of the Society, and the Learned and Scientific Associations with which this Society was in correspondence.

The following contributions were announced :—"Catalogue and Supplements of the Melbourne Public Library." "Bentham's Flora Australiensis," Vol II.—by Dr. F. Mueller. "Account of the Royal Danish Agricultural Association," for 1862 and 1863—by the Society. "Fortieth Annual Report of the Silesian Society for National Culture," 1862—by the Society. "Year Book of the Imperial Royal Geological Institute," 13 Vols.—by the Society. "Account of the Sitting of the Royal Bavarian Academy at Munich," Part 3, Vol. I.—by the Society. "Transactions of the Silesian Society for National Improvement, Divisions of Natural History and Medicine," 1862, Vol. II. concluded—by the Society. "Transactions of the Mathematical and Physical Classes of the

Royal Bavarian Academy of Science"—by the Society. "Royal Northern Society of Antiquaries, Runique Inscriptions, and Reports of Proceedings"—by the Society. "Meetings of the Royal Physics Economic Society of Köeningsberg," 1st and 2nd Divisions, 1863—by the Society, through the Prussian Consul. "Obituary Notice of John Andrew Wagner," spoken at the Public Meeting, 28th November, 1862—by Dr. Von Martins, of Munich.

Mr. T. E. Rawlinson read a paper on the "Probable Erosion of the Mountain Ranges of Gipps Land."

In the discussion that followed, Mr. Aplin remarked that on the top of Mount Useful was found tertiary drift and portions of basalt. Mr. Ligar described the original covering of the whole of the dividing ranges, from the eastern base of Mount Kosciusko, sweeping over the Maneroo plains and the dividing ranges, through Victoria westwards, to have been at one period an extended elevated plain of basalt. That since their original formations they have in all likelihood attained their present elevation, and have gradually been worn down, denuded, and in fact eroded into gullies and mountain ranges, such as we have now presented to us, by the action of water. Both Messrs. Ligar and Aplin dissented from the author's statements relative to the granite topping of Mount Useful, but in other respects concurred in the views of Mr. Rawlinson relative to the actual erosion of these ranges.

Mr. Ellery then read a paper on "Spectrum Analysis," and gave a verbal statement of the "Progress made in Spectrum Analysis of the Heavenly Bodies."

A lengthened discussion arose on this paper, in which the President, Messrs. Ligar, Aplin, Professor Halford, and other members took part, in reference to the present state of the science, and the probability of its greater development by the application of new powers and more complete appliances. Mr. Ellery remarked that one object he had in view in bringing forward the subject in the form in which it was submitted, was from the belief that it was a duty of the departments of this country, when they had experiments or other matters of interest in hand, beneficial to science and to the community at large, to submit them in the shape of short reports through the Royal Society.

(Signed) John J. Bleasdale, D.D.

24th July, 1865.

24th July, 1865.

Ordinary Meeting.

The Rev. J. J. Bleasdale, President, in the chair.

A communication from Mons. De Grad, of the Geographical Society of Paris, to Dr. Mueller, respecting an exchange of Transactions with this Society, was read.

The gentlemen nominated at the last meeting were balloted for and declared duly elected.

Mr. Flanagan was also balloted for and elected a Life Member of the Society.

Professor Halford read a paper "On the Skeleton of the Gorilla in the National Museum," which was illustrated by a human skeleton and a skeleton of a male Gorilla, with skulls of various Apes from the National Museum.

In an interesting discussion that followed, Dr. Thomas disagreed with the conclusions arrived at by Professor Halford. Dr. Rudall endorsed them. Mr. Aplin defended Professor Huxley, and quoted from his work, in order to show that that gentlemen's views with regard to the comparison of the skeletons of Man and the Gorilla had been incompletely set before the public. Professor M'Coy, at some length, defended Professor Halford. The President also adopted the conclusions arrived at by Professor Halford, "not speaking as an anatomist, but as a man." Mr. Clarson and other members having spoken, Professor Halford replied to the various objections offered, and answered several questions put to him, condemning the work of Professor Huxley, and maintaining his own opinion as set before the Society.

(Signed) Robert L. J. Ellery.

14th August, 1865.

14*th August*, 1865.

Ordinary Meeting.

R. L. J. Ellery, Esq., Vice-President, in the chair.

The following gentlemen were balloted for as Ordinary Members and declared duly elected :—

Mr. William P. Bonwick.
Mr. R. Willan.
Mr. C. C. Dowling (P.M., Creswick).

The Hon. Secretary announced that the Agent of the Peninsula and Oriental Company had kindly undertaken the delivery of the Society's Transactions in India.

Professor M'Coy read his paper "On the Discovery of Cretaceous Fossils in Australia," and exhibited the characteristic fossils. The Professor announced that this discovery completed the hitherto wanting links of evidence of the existence of the various European formations between the Primary and Tertiary rocks of Australia, most of which had been announced by himself to this Society.

Mr. Ellery exhibited the Spectroscope to the members and visitors, showing the spectra of various metals, and also the pecular spectra of blood. Mr. Ellery briefly enumerated some of the leading features

of this application of science, and its importance in obtaining evidence of the presence of matter, although it might exist in such infinitesimal quantities that the most careful analysis would hitherto have failed to detect it.

(Signed) Robert L. J. Ellery.

4th September, 1865.

4th September, 1865.

Ordinary Meeting.

R. L. J. Ellery, Esq., Vice-President, in the chair.

Contributions from Royal Society of Tasmania were laid on the table.

Mr. Rawlinson read a paper on "The Advisability of Working the Ethno and Geographical Section."

Messrs. Bonwick and Ellery spoke in favour of such a course, which they hoped would be but a prelude to the organization of the other sections for work.

(Signed) Alex. Kennedy Smith.

September 26th, 1865.

26th September, 1865.

Ordinary Meeting.

Alex. Kennedy Smith, Esq., Hon. Treasurer, in the chair.

The Honorary Secretary briefly called the attention of the members to the loss sustained by the Society owing to the recent death of the Hon. John Macadam, M.D., and to the intimate and prominent connection he had held with the Society for so many years, first as Hon. Secretary, and subsequently as Vice-President, until, from the multiplicity of his engagements, he had of late been precluded from his usual constant attendance. That in losing Dr. Macadam the Society had lost one of its earliest members, and also a Life Member. That under these circumstances he (the Hon. Sec.) begged to move—

"That a request be forwarded from this meeting to the Council, "that it would forward to the widow of Dr. Macadam a letter of "sympathy and condolence, and also cause such record to be inserted "in the journals of this Society."

Seconded by Mr. J. B. Were, and carried.

As a mark of respect, and in memory of the deceased, the meeting then adjourned.

(Signed) Robert L. J. Ellery.

16th October, 1865.

16*th October*, 1865.

ORDINARY MEETING.

R. L. J. Ellery, Esq., Vice-President, in the chair.

The following gentlemen were balloted for as Ordinary Members and declared duly elected :—

The Hon. John P. Bear.
Peter Beveridge, Esq.

The following contributions were announced :—"Year Book of the Imperial Royal Geological Institute, Vienna," 1864, Vol. XIV. "Catalogues," S. Calvery & Co., Berlin, Ancient and Modern. "Monthly Report of the Royal Prussian Academy of Science at Berlin," 1861. Nos. 80, 81, and 82 of the Journal, and List of Members to November, 1864, of the Geological Society of London. "Address at the Annual Meeting of the Royal Geographical Society," May, 1865. "Proceedings of the Silesian Society for National Development," 1861, Vol. I. "Philosophy and History," Vols. I. and II. "Natural History and Medicine." Annual Report of the Society for 1860. "Fossil Fauna Silesian Diluviæ at Sedewitz, near Oels, in Lower Silesia"—by Dr. Ferdinand Von Roewer. "Boston Society of Natural History," Journals, Vol. VII., Nos. 2, 3, 4. Proceedings, Vol. IX., Parts 1 to 20; Vol. VIII., Parts 1 to 20. Vol. VII., Parts 16 to 21. "Constitution and Bye-Laws." "American Academy of Arts and Sciences," Vol. V., Parts 1 to 22. "Lieut. Col. Dixon (Typographical Engineer, Chicago, U.S.) on Mason and Dixon's Line," 1862. "On the Improvements in the Harbours of Lakes Michigan, St. Clair, Erie, Ontario, and Champlain," 1859 to 1860. "Smithsonian Report," 1861, 1862. "Patent Office Reports," Vols. I. and II., 1860; I. and II., 1861. And on "Agriculture," 1861. "Introductory Reports of Patent Commission," for 1863. "Smithsonian Collections," Vols. I. to IV., 1862; Vol. V., 1864. "Journals of the Royal Dublin Society," No. 20 to 23, for 1861.

Mr. Thomas Harrison read a paper "On the Probable Astronomical Causes of the Contortion of the Ancient Rocks, and the nearly Meridianal Strike of the Palæozoic Strata."

A discussion took place on the views put forth by the author, in which the Chairman, the Hon. Secretary, and Mr. Were took part, objecting generally to the assumed basis of Mr. Harrison's theory, and to the inferences deduced therefrom.

(Signed) ROBERT L. J. ELLERY.

27th November, 1865.

6th November, 1865.

ORDINARY MEETING.

There being no quorum at 8 p.m., the meeting lapsed.

T. E. RAWLINSON, Hon. Sec.

(Signed) ROBERT L. J. ELLERY.

27th November, 1865.

27th November, 1865.

ORDINARY MEETING.

R. L. J. Ellery, Esq., Vice-President, in the chair.

The following contributions were announced :– Nos. 31 to 34, with three plates, of the "Fragmenta Phytographiæ Australiæ"—by Dr. Mueller

Mr. James Osborn, Jun., was balloted for and declared duly elected as a Life Member.

Mr. T. J. Crouch and Mr. H. K. Rusden were also balloted for and duly elected as Ordinary Members.

The Letter of Condolence to Mrs. Macadam, on the motion of Dr. Barker, seconded by Dr. Nield, was ordered to be inserted in the Minutes of this Meeting :—

(COPY)

"Royal Society of Victoria,

"Melbourne, 20th November, 1865.

"Dear Madam,

"On behalf of the Council and Members of the Royal Society of Victoria, I have to perform the sad duty of conveying to you their deep felt sympathies and sorrow for your recent bereavement and loss, by the untimely death of your late husband, who for many years was intimately connected with this Society.

"As Honorary Secretary, and afterwards Vice-President of this Society, his name was connected with events which have been heard over the civilized world, and we can only mourn with you his removal from the extended sphere of usefulness which he has of late occupied.

"Accept, on behalf of yourself and son, the deep felt sympathy of the condolence of the Council and Members of the Royal Society of Victoria, in this your hour of affliction and trial, with the expression of their earnest hope that you may find consolation in the remembrance that your late husband fell in the path of duty, regretted and esteemed by those who knew him.

"I remain,

"Dear Madam,

"Yours most faithfully,

(Signed) "JOHN J. BLEASDALE,

"President of the Royal Society of Victoria.

"Mrs. Macadam."

The Chairman announced that the General Meeting would be held on the 4th December, to receive the Report of the Council and Treasurer's Balance Sheet, and nominate candidates for the offices vacated with the close of the session.

(Signed) Robert L. J. Ellery.

4th December, 1865.

4th December, 1865.

Annual General Meeting.

R. L. J. Ellery, Esq, Vice-President, in the chair.

THE REPORT OF THE COUNCIL

was read by the Hon. Secretary, as follows :—

"In submitting their Report for the Session of 1865, your "Council feel justified in offering to the Members of the Royal "Society their congratulations on the results of the year now drawing "to a close. The work of the Session, although not furnishing a "large visible result, has been very satisfactory in other respects, in "enabling the Society to clear away old liabilities, and leave to the "succeeding Council comparative freedom from pecuniary embarrass-"ments to begin the new year. The progress of the Society would "have been now visible, but for the apathy and indifference of some "who were, and others who are yet, nominally Members, but who "have stood aloof, without rendering that aid which would have "been so valuable, if freely given, as contributions to our Meetings "in the form of papers embodying the scientific facts and discoveries "which were available from time to time.

"Although your Council have had to regret to some extent the "want of earnest effort on the part of some, they gratefully acknow-"ledge the contributions received from others, and feel confident in "stating that whilst the great actual scientific value of some of the "papers are beyond question, the average of them will bear a "favourable comparison with those read during previous years.

"In expressing such an opinion your Council, however, wish it "to be distinctly understood, that whilst they regard the progress of "the past year as satisfactory, when considered in connection with "the difficulties under which the Society has hitherto laboured, they "expect and hope that, as the obstructions to progress which have "hitherto existed are removed, individual Members will feel that it "is incumbent on them to lend vigorous aid in furthering the "objects for which the Society was originally formed, namely, the "cultivation of literature, art, and science. Such aid can be given "by each Member, in accordance with his opportunities and know-"ledge, in collecting such new facts as may become known to him, "and contributing them to the general store of the Society.

"In the early part of the Session, your Council, having received "information that the Government had, through Parliament, made "provision to defray the cost of publishing the Society's arrears of "Transactions, lost no time in realizing so desirable a result as the "issue of those papers which, up to that time, had not been pub-"lished. By this means Volume VI. was issued in the early part of "the Session to the Members, and copies distributed to the various "scientific societies at home and abroad with which this Society is "in communication.

"At the beginning of the Session, your Council hoped to have "been enabled to place their current Transactions before you in a "permanent form, either in parts or complete, during the current "year; but owing to the non-payment of the subsidy voted by "Parliament, they have deemed it more prudent to wait until the "present liabilites for printing are satisfied before incurring any "further debts. In all other respects the financial condition of the "Society is satisfactory, as may be seen by reference to the "Treasurer's Balance-Sheet, the working expenses of the Society "having been reduced during the past year. At the request of your "Council, the Treasurer appointed a Collecter to obtain arrears of "Subscriptions from Members, and the results have been satisfactory. "Some few of the old Members who had fallen into arrear have "chosen to terminate their connection with the Society, but their "places have been more than filled by the accession of new Members "during the year. In this respect the anticipations of your Council "have been more than realized—four Ordinary Members and one "Subscriber to the Publishing Fund have elected to become Life "Members, whilst the roll of Ordinary Members has been increased "by the addition of nineteen new names.

"Dr. Von Martins and Dr. Schultz were unanimously elected "Honorary Members of the Society, in acknowledgment of their "valuable aid to science, and as a mark of the esteem in which they "are held by the Society, for the valuable contributions received "through them from time to time.

"During the year correspondence has been opened with, and our "Transactions forwarded to, the Scientific Society of Batavia, to the "Italian Minister of Public Instruction, to the Irish Statistical "Society, and the Society of Naval Architects.

"The usual presentation copies of our Transactions have been "forwarded, and eighty other copies sent to corresponding scientific "and public societies, and to Life and Honorary Members residing "abroad.

"Your Council has received an intimation through His Excellency, "that Her Majesty has been graciously pleased to accept Vol. VI. "of the Transactions of the Royal Society of Victoria, and expressed "her appreciation of the present. Also your Council has received

"an acknowledgment of the receipt of Vol. VI. by the Emperor of "France, who has tendered his thanks for the same.

"Your Council begs to acknowledge its obligation to the Agent "of the Peninsular and Oriental Company for the gratuitous trans- "mission of the copies to India, and to Mr. Dwight for similar "transmission through the Colonies and the Mauritius.

"Exclusive of the Annual Meeting, there have been nine Ordinary "Meetings, at which not less than eight papers were read.

"During the Session eighty-five books and pamphlets, with "illustrations, have been added to your library, as contributions from "Foreign and Home Societies.

"The commencement of the Session was inaugurated by an "Exhibition of Colonial Gems and Jewellery, and your Council feel "satisfied that the results have been highly beneficial, showing the "character and contrast between the cut and uncut gems, and in "affording instruction to miners visiting the Exhibition in reference "to products of great value which are found in Victoria, and require "but care and a little practice to select from the commoner rocks "amongst which they are usually found.

"The following are the titles of the papers read during the "Session :—

"1. Victoria as a Field for Geologists, by Mr. Thos. Harrison.

"2. Report on the Gem Exhibition, by Rev. Dr. Bleasdale, D.D.

"3. On the Probable Erosion of the Mountain Ranges of Gipps "Land, by Mr. T. E. Rawlinson.

"4. On Spectrum Analysis, by Mr. R. L. J. Ellery.

"5. On the Skeleton of the Gorilla, by Professor Halford.

"6. On the Discovery of Cretaceous Fossils, by Professor M'Coy.

"7. On the Advisability of Working the Ethno and Geographical "Sections, by Mr. T. E. Rawlinson.

"8. On the Probable Astronomical Causes of the Contortions of "the Ancient Rocks, and the nearly Meridianal Strike "of the Palæozoic Strata, by Mr. Thos. Harrison.

"Mr. R. L. J. Ellery one evening exhibited the Spectroscope.

"Your Council cannot close this Report without recording their "profound regret at the loss by death of the Hon. Dr. John "Macadam, one of the most active Members of the Society for "many years.

(Signed) "Thomas E. Rawlinson,
"Hon. Secretary."

The Report was adopted.

The Treasurer's Balance-Sheet was then read as follows :—

Balance-Sheet—Hon. Treasurer in Account with Royal Society.

Dr.

1864.—December 1st.	£ s. d.	£ s. d.
To Balance, per Audited Balance Sheet, General Account	10 19 3	
„ Publishing Fund	173 13 0	
		184 12 3
1864-5.—December 1st to December 30th.		
To Cash, viz. :—		
4 Life Subscriptions	41 10 0	
Subscriptions and Entrance Fees, including Interest on Deposit, £10 8s. 4d. ...	197 4 4	
		238 14 4
		£423 6 7
To Balance General Account		16 18 0
„ „ Bank Deposit		215 3 0
		£232 1 0

Cr.

1865.—December 31st.	£ s. d.	£ s. d.
By Postages and Petty Cash	43 13 8	
„ Treasurer's ditto	10 0 0	
„ Clerical Assistance and Commission on Collection ...	22 9 2	
„ Incidentals	79 9 9	
„ General Printing	35 13 0	
		191 5 7
„ Balance		232 1 0
		£423 6 7

We, the undersigned Auditors, appointed by the Royal Society of Victoria have examined the Honorary Treasurer's Accounts for the year 1865, and find them correct.

(Signed) FERD. MUELLER, M.D.
JAMES EDWARD NEILD, M.D.

4th January, 1865.

(Signed) ALEX. KENNEDY SMITH,
Honorary Treasurer.

4th January, 1865.

Mr. Thos. H. Rawlings moved, and Mr. Bonwick seconded—"The "appointment of Dr. F. Mueller and Dr. Neild as Auditors of the "Society, to examine and report upon the statement now produced."

Upon the motion of Dr. Mueller, seconded by G. S. Lang, Esq., the following resolution was carried—"The best acknowledgments "of the Society be accorded to the Office-Bearers for the zealous "services rendered during the year, and for the judicious manner in "which the objects of the Society have been carried on, for securing

" its prosperity, and the advancement and concentration of scientific " labour in this country."

The Hon. Secretary brought the Amended Rules, as recommended by the Council for adoption, before the meeting.

The proposed Rules (see copy of Laws, 1865) were read *seriatim*.

It was moved by Mr. T. E. Rawlinson, seconded by Mr. Thos. H. Rawlings, and carried—" That the Laws read and amended at this " meeting be received and adopted as the Laws of the Royal Society " of Victoria."

The Secretary then announced that, in accordance with Law IX. of Amended Rules, the President and Vice-Presidents, Treasurer, Secretary, Librarian, and Custos, with six Members of Council (Messrs. Von Guerard, Halford, Crook, Were, Lewis, and Bosisto), retired from office at the first meeting in January, and that nominations would that evening be received to supply the vacancies.

(Signed) John J. Bleasdale, D.D.

15th January, 1866.

List of Office-Bearers,

PRESIDENT'S ADDRESS, AND TRANSACTIONS

FOR THE YEAR 1866.

Royal Society of Victoria.

1866.

President.

R. L. J. ELLERY, ESQ., F.R.A.S., &c.

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THOMAS HARRISON, ESQ.

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THOS. H. RAWLINGS, ESQ., &c. &c.

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* EUGENE VON GUERARD, Esq.

* Mr. Von Guerard was elected 11th June, 1866, *vice* Dr. Mueller resigned.

Royal Society of Victoria.

ANNIVERSARY ADDRESS

OF

The President,

MR. ELLERY (*Government Astronomer of Victoria.*)

[Delivered to the Members of the Royal Society, at the Anniversary Meeting held on the 2nd July, 1866.

GENTLEMEN OF THE ROYAL SOCIETY,

I esteem it a great honour that I have been elected to assume the office of your President this year. In that capacity it now devolves on me to address you on the subject of the progress of your Society during the past year, and, following the good example of the older scientific societies of the mother country, give a brief retrospect of the progress in this colony and other parts of the world of those branches of knowledge embraced by your Society.

But, in the first place, it becomes my mournful duty to record the loss of one of your oldest and most energetic members, John Macadam, Doctor of Medicine in the University of Glasgow.

Dr. Macadam died on the 2nd of September, 1865, on board the steamship *Alhambra*, on his way to New Zealand, to which colony he was proceeding on professional business. He had been for a long time previously in bad health, induced in a great measure by the incessant and harassing

duties pertaining to the various offices he held, and much increased by an accident, causing fracture of the ribs, he met with on his return from New Zealand, a short time previously.

Dr. Macadam was born at Northbank, near Glasgow, in May, 1827. He first studied under Professor Penny, at Glasgow, to whom he was afterwards appointed principal assistant. He subsequently entered at the Edinburgh University, under Professor Gregory. He arrived in this colony in 1855, under an engagement as Lecturer on Chemistry and Natural Science in the Scotch College, Melbourne. Dr. Macadam was one of our earliest members of the Philosophical Institute of Victoria, afterwards the Royal Society. He held the office of Honorary Secretary for many years, and on him devolved the task of editing the "Transactions," all of which, except the last issued, were published under his superintendence. He was also a Fellow of the Royal Scottish Society of Arts, and a Fellow of the Faculty of Physicians and Surgeons of Glasgow. Of late years he held the appointment of Lecturer on Theoretical and Practical Chemistry, at the Melbourne University, which he retained till the time of his death.

Although your last session was not a very busy one, several interesting and valuable papers were read, giving rise in many instances to animated and instructive discussions.

Numerous and valuable additions were made to your library by kindred societies abroad; and we are now in regular receipt of the "Transactions" of ninety-five scientific and literary bodies in Europe and America.

The resumption of the publication of the "Transactions," which had for several years unfortunately been in abeyance, is a noteworthy fact of your last session. The last volume which was issued to your members contains the Transactions

of the Society during the years 1861-62-63, and 64. Arrangements have now been made that will, I trust, prevent our work getting thus into arrears for the future. It very frequently happens that it is of great importance that papers and communications read before this Society should be published without delay, in some cases to secure priority of discovery, and often to make known useful information. Your Council have, therefore, decided to publish the papers at least once a quarter.

At the first meeting of the Society in May, your late President, the Rev. Dr. Bleasdale, gave his inaugural address. An instructive and suggestive paper by Mr. Thomas Harrison, entitled "Victoria as a field for Geologists," was read at the next meeting on the 22nd May.

At the June meeting, Dr. Bleasdale laid before the Society his report on the Exhibition of Colonial Gems and Jewellery, and Works of Art in the Precious Metals, which had taken place a short time previously.

A paper entitled "The Probable Erosion of the Mountain Ranges of Gipps Land," was also read by your late Secretary, Mr. Thomas Rawlinson. A most interesting discussion followed the reading of this paper, which related principally to the denudation of the mountain lands of that district, and the formation of the alluvial plains to the southward of them. At the same meeting, I also gave a short account of the application of Spectrum Analysis to the Heavenly Bodies.

At the next meeting a most important paper "On the Skeleton of the Gorilla in the National Museum," was read by Professor Halford, which will be perused with interest by all engaged in the study of comparative anatomy. The comparisons of the human skeleton with that of the gorilla and many other apes was most exhaustively discussed. You are aware, gentlemen, of the difference of opinion that

exists among our most eminent comparative anatomists and osteologists on this subject. Professor Halford takes ground in opposition to Professor Huxley's views, and although I believe few of us will venture to ally ourselves to any particular side of the moot points, the paper will form a valuable addition to our knowledge of comparative anatomy.

Professor M'Coy read a paper at our meeting on the 14th of August, in which he announced for the first time with certainty, the existence of the Cretaceous formations in Australia. Some fossils which had been brought down from the head of the Flinders river, by Messrs. Carson and Sutherland, which were laid before the meeting, had enabled Professor M'Coy to arrive, without doubt, at this conclusion. This discovery, Professor M'Coy told us, nearly fills up the great series of marine mesozoic formations supposed to be absent in Australia when he arrived here, but most of which he has recognised and demonstrated from palæontological evidence before the meetings of our Society.*

The last papers of the session were "On the desirability of working the Ethnographical and Geographical Section of the Society," by Mr. Rawlinson; and a very ingenious but speculative one entitled "Probable Astronomical Causes of the Contortions of the Palæozoic Strata in Australia," by Mr. Harrison.

At the annual closing meeting of the session, some important alterations were made in the laws of the Society, which past experience had shown to be desirable.

Intimately connected with the progress of the Society is the advancement and well-being of our public scientific establishments, and to these and their results during the past year I would now briefly advert.

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* Professor M'Coy informed me a few days since, that Mr. Sutherland had just sent him most important new fossils confirming the above, which he intends shortly to bring before the Society.

The Geological Survey, under the direction of Mr. Selwyn, one of your members, has made considerable progress. There has been, however, a less number of those splendid maps produced than usual, in consequence of most of the field surveyors having been appointed in 1864 to examine certain portions of the colony which were hitherto unexplored. Their very interesting reports on these districts are now in course of publication.

During the past year, however, they were recalled, to continue their regular field works, the director having selected for survey "those lines of country" which he considered, if carefully mapped, would be most likely to afford valuable data and information on several very important points affecting the probable auriferous character of untried reefs, and the extension into new ground of deep leads now working, as well as the existence of others not yet developed.

The labours of the survey during the past year in this direction, especially in the elaborate and carefully-worked survey of portions of the Moorabool valley, near the Steiglitz gold-field, "have enabled them to arrive at conclusions which, if true, are not only geologically interesting, but may become of great value in preventing useless outlay of capital and labour. There appears, however, a very general indisposition on the part of mining investors in the colony to accept the conclusions or to be guided by the deductions and experience of the scientific geologist, and his advice and opinion, though frequently asked for, is seldom acted on if it differs from that of the working miner. Even in the short history of Victoria, instances are not wanting in which thousands of pounds would have been saved had an opposite course been taken."

A report of the various examinations and experiments conducted by Mr. Newbery, analyst to the geological

survey, will be found to contain valuable and interesting matter. The investigations concerning the nature and productiveness of the water of the salt lakes will be continued, also those in connection with the possible manufacture of hydraulic and other cements,—both of which are not unlikely to become important industries of Victoria.

During his recent examination of the upper portions of the Yarra gold-fields, and of other districts, especially of Eastern Gipps Land, Mr. Selwyn has been enabled to make several important additions to the geological sketch-map of the colony.

Emanating from this department is a report by Mr. Ulrich, assistant geological surveyor, on the Freiberg Silver-mining Company, St. Arnaud, containing some generally interesting and very valuable observations on the argentiferous lodes of that district.

Mr. Selwyn has examined the Western Port and Cape Paterson coal-fields, and reiterates his former opinion of the improbability of a really good workable coal-field ever being found in that district. He states that "there are one or two places some miles from Cape Paterson and Griffith Point where it might be advisable to make a few borings; but he entertains very little hope of even these, if carried out, leading to the discovery of any really profitable workable coal-field. The ground is, however, untested, and while a chance of a successful result remains it should not, in his opinion, be neglected."

Mr. Campbell, of Traralgon, has discovered excellent coal among the river drift in the bed of the River Tyers, but not the seam from which it is derived, "which can easily be found if carefully sought for. If it occurs sufficiently thick and extensive to work profitably, it would undoubtedly prove most valuable." Mr. Selwyn proposes visiting the locality shortly, to ascertain the probable extent and

thickness of those seams of coal already discovered, and also whether there are not others of better quality existing in the neighbourhood.

The Botanical department, so ably conducted by one of our members, Dr. Ferdinand Mueller, claims a place in our notice of scientific progress. By his continuation of local phytographical researches, Dr. Mueller has afforded to the president of the Linnæan Society the necessary aid for writing the third volume of the universal work on Australian plants. The *Fragmenta Phytographiæ Australiæ*, which have from time to time been presented to our society as they issued from the press, have now reached to the fifth volume. The *Hortus Siccus* of the Botanical Museum has received an important addition in the original typical collection of the late James Drummond, of Swan River, whose researches for over twenty years have familiarized botanists with the flora of the south-west portion of this continent.

The addition of a laboratory to the Botanical department, for purposes of chemical and technological inquiry into the value of various vegetable products in the colony, is a step in the right direction. There is ample field for such research, and I hope our Society will duly be made acquainted with the results of these inquiries. It will be interesting to you to know that Dr. Mueller has now succeeded in raising a large number of the cinchona or Peruvian bark trees, as well as plants of ginger and arrowroot, and others of great commercial value, during the last year. He is now prepared to commence plantations of these in fitting parts of our mountain lands, as soon as the necessary financial aid shall be afforded.

The importance of establishing plantations of the cinchona cannot be well over-estimated, for the indiscriminate stripping of the trees in the South American forests, com-

bined with other causes, has so limited the supply from that part of the world, that the establishment of this plant in other localities has become an absolute necessity.

The immense consumption of quinine and other products of the cinchona bark, in India and tropical climates especially, and the great commercial value which these materials have attained, have resulted in the formation of extensive plantations in the Neilgherry Mountains, which have thriven beyond expectation. I have no doubt many of you will recollect Dr. Markham's expedition into the cinchona forests of South America, in order to obtain plants and seeds for those plantations, and the great difficulty and danger he incurred in getting those he collected to the seaboard.

In astronomy, meteorology, and magnetism, our Observatory has kept its accustomed watch. During the past year its efforts have been principally directed to the completion of a catalogue of stars—now in the printer's hands—which includes most of the work done at Williamstown prior to the removal of the Observatory from that place to Melbourne, as well as the publication of the astronomical work for the years 1863, 1864, and 1865.

Some years ago, Dr. Argelander, the director of the Observatory at Bonn, completed the task of surveying the northern heavens, and forming a catalogue of all stars down to the ninth and tenth magnitude, thereby giving the positions of nearly half a million stars. The completion of this undertaking forms one of the greatest practical achievements in modern astronomy. The Royal Astronomical Society of London, fully alive to the value of this work, determined to try to get a survey of the southern heavens, on the same elaborate scale, by British means, and finally this honourable task was allotted to the Royal Observatory at the Cape of Good Hope, the Madras Observatory, and the Melbourne Observatory. The preparations necessary for commencing

this work by the beginning of the current year have also occupied much of the attention of the officers of the establishment. In February last, the survey was fairly under way. The portion of the heavens that it is proposed shall be surveyed by our Observatory will occupy many years, and as it intended that our part shall be completely reduced to mean places for a fixed epoch, the necessary calculations and reductions will tax the present staff rather heavily.

A self-registering anemometer, on Dr. Robinson's principle, and similar to that used at the Royal Observatory, Kew, was added to the appliances of the establishment last year, and now daily yields its faithful and continuous record of the velocity and direction of wind, and their changes. Arrangements have been made for adopting self-registering instruments for meteorological and magnetic records, as far as possible; which will, of course, not only relieve the department of a large amount of mere routine work, but render the registration of the several phenomena incomparably more complete than they could possibly be from observations at stated intervals.

Professor M'Coy, in his presidential address in 1864, dwelt at some length on the subject of the great Southern telescope, and on the action your society had taken respecting it in former years. It will, therefore, I think, be of some interest to you to hear of the progress that has been made in this matter. At the time of Professor M'Coy's address, the munificent offer by Mr. Lassels of his great reflecting telescope to the Melbourne Observatory had just reached us, and it was fully expected that this famous instrument would have been by this time erected in Melbourne, our Legislature having voted a sum of money to cover the cost of conveyance and of some necessary alterations to fit it for these latitudes. Subsequent correspondence,

however, between the Board of Visitors to the Melbourne Observatory and the Royal Society of London, led the board to recommend that Mr. Lassell's offer should be declined. This recommendation was acted upon, and the additional amount necessary to obtain a new telescope of the most suitable construction was afterwards voted by Parliament. You will be glad to learn that the new telescope is now being constructed by Mr. Grubb, of Dublin, and, it is fully expected, will arrive by, or shortly after, the beginning of next year. It will be of the form known as the Cassegrainian ; the large speculum will be four feet diameter, and about thirty-five focal length ; the tube is to be of open lattice-work of steel. It will be mounted equatorially, and driven by clock-work. An apparatus for repolishing the speculum will accompany the telescope. The whole cost is to be £4,500 in Dublin.

While speaking of the scientific work going on in the colony, outside the Royal Society, the geodetic and coast surveys require some notice. The latter undertaking, under Commander Cox, R.N., has made considerable progress. The more tedious parts of the survey—namely, our two principal harbours, Port Phillip and Western Port—have been completed ; and the magnificent chart of the former, which came out from the Admiralty some months since, is sufficient evidence of the complete way in which the admiralty surveyors, under Captain Cox, perform their work. The survey is now being extended along the coast line east of Western Port.

The geodetic survey, under my superintendence, has also made considerable progress. The principal operations of scientific interest during 1865 were the completion of the primary triangulation westwards to the South Australian boundary, and its advance into the Australian Alps in the north-east portions of the colony, and its extension along

our coast line eastwards as far as the entrance of the Gipps Land Lakes. The maps of this survey are now considerably advanced, and a new map of the colony, based on the accurate determination of the surveyors employed, is in progress.

There have been some important improvements and extensive additions made during the past year to our national museum. The half of the museum building erected by order of Parliament two years ago, adjoining to the University, contains a very fine hall about 150 feet by 60, lofty, well lighted, and ventilated, yet perfectly free from the dirt and dust of the town, owing to the extensive planted grounds surrounding it. The students of the University are referred daily to the various collections for illustrations of the scientific lectures; and of the general public, 78,536 visited the building last year. In this way the best practical and general use is made of the collections, of which upwards of 100,000 specimens are now fully classified and named by the director, Professor M'Coy.

The ground floor on the north-east side contains a nearly perfect collection of minerals, all carefully labelled, after testing, with their chemical composition in symbols and system of crystallisation, in addition to the name of the locality, giving the greatest facility for study. On the same side of the hall is a magnificent collection of skeletons, from those of the gorilla down to the fishes, including elephant, whale, manatu, and several hundred others, most instructively arranged in zoological series; and a commencement has been made of a novel plan for facilitating the study of osteology in the museum, by marking the various bones with a number corresponding with the anatomical name of the part set for that length in inscriptions on the walls. On the north-west side the floor contains the tertiary quadrupeds, the bones of which may thus be compared with those of the living allies.

The whole of the south half of the floor is occupied by the mining and metallurgical illustrations, all very fully labelled and illustrated for public instruction. The collection of models of mining machinery far exceeds that of the Government School of Mines in London, and was intended by Professor M'Coy to facilitate the establishment of a school of mines.

A handsome gallery runs round the room, on which the zoological collections are arranged according to a new plan, by which the laws of representative species and centres of creation are well illustrated. The great zoological regions of the earth, in accordance with the most recent researches, are inscribed on the walls; and the collections of the inhabitants of each kept by themselves, each group zoologically arranged and fully labelled with order, family, genus, species, and locality. The collections of Central and South America occupy the west gallery, those of Central and South Africa the east gallery, Central and South Asia the north, Oceanica, &c., the south gallery, &c.

Amongst the more interesting additions made last year, are the finest series of the old and young gorillas known, with their perfect skeletons; bones of the dodo, sent by our former president, Sir Henry Barkly, to Professor M'Coy; laniary teeth of Thylacolea, from near Geelong; a splendid series of the Psittacidæ, newly collected by Mr. Wallace in the islands north of Australia; a specimen of Forster's great Penguin, of which so few examples exist; and the only known specimen of the *Pithecia Wurmbi*, which approaches in the head far nearer to man than the orang, chimpanzee, or gorilla; and lastly, the most perfect specimen known of that excessively rare and interesting object, the *Pentacrinus caput-medusæ*, the last living type of the stalked crinoidæ of geological early times.

Our Public Library, too, has acquired additional attrac-

tions. Besides a large increase in its literary treasures, the picture gallery has been much enriched, more especially by the acquisition of some beautiful paintings by Guerard, Chevalier, and Gritten. The Museum of Art has also been further developed, and the ground floor is now almost exclusively occupied by copies of the best works in sculpture, not only of the modern schools, but including also faithful casts from the Elgin and other Greek marbles.

The successful casting of the Burke and Wills monument by Mr. Summers is another noteworthy fact of our progress. Few know the enormous trouble and pains the production of this immense bronze casting cost this courageous artist, from the time of his first shaping his model in clay to the time the statue was lifted on its pedestal. Not only does it reflect great credit on its author as a splendid work of high art, but also as an achievement in bronze-founding on a large scale.

The Acclimatisation Society has been steadfastly progressing in its useful labours. Prominent among the results of the year are the importation of a flock of that most valuable animal, the Angora goat, and the completion of the arrangements for another consignment of salmon ova, of whose safe arrival a few weeks ago you are no doubt aware.

The further exploration of the interior of Australia is in progress. The expedition fitted out under the auspices of the ladies of Victoria, assisted by a personal donation from Her Majesty the Queen, and further aided by contributions from the Governments and people of the neighbouring colonies, with the predominant view of unveiling, if possible, the fate of Leichhardt, under the leadership of Mr. M'Intyre, is exploring the more northerly portions of the Australian continent. Even should this search be barren in its primary object, the information which must inevitably result from

the travels of the expedition will in some measure repay the ladies of Victoria for their chivalrous undertaking.

With the year's history of the Royal Society of Victoria and of our various scientific establishments, it cannot escape our notice how much progress has been made in the colony generally. In the mechanical arts we especially notice a healthy and steady advancement. Our foundries and engineers' establishments are constructing railway, marine, and mining machinery of a class and at a cost that promises soon to compete with our great factories at home. Manufactories are being rapidly established among us. Many chemicals, for which there is a large demand in the colony, are now manufactured here on an extensive scale. Earthenware and pottery are produced in large quantities, and great improvement is perceptible in the quality of the productions during the last year. The distillation of essential oils from our eucalypti, the manufacture of perfumery, and the utilisation of the grass tree, from which alcohol and a most useful gum resin are obtained in large quantities, are now being carried on profitably; and time is only needed to render these undertakings the fountains of special productions, which will add much to the commercial prosperity of our adopted country.

Before concluding, I must not omit to give a brief retrospect of the progress of science in the western world. So many items of the greatest interest appear, if we glance over the science harvest of 1865, that I must content myself with a reference to only the most salient points.

In the great advancement that has been made in physical science, the one subject that seems to stand out beyond all the rest is the result of the continued researches into heat and radiation, by Tyndall and others. One point of prominent interest in connection with this branch of science appears to have been determined—namely, that the sun's

rays pass through space without loss, and only become developed as heat as they enter our atmosphere, the density and humidity of which govern the amount developed. Such being the case, it does not seem improbable that, however distant a planet may be from the sun—whether near or far—whether it be Mercury or Neptune, it receives the same amount of heat as the Earth, the character of their enveloping atmospheres entirely governing the supply. The researches of Messrs. Huggins and Thompson, and Father Secchi in Florence, on the spectra of the heavenly bodies, have also ripened into most interesting results. The examination of several of the nebulæ by Mr. Huggins with the spectroscope has led to the opinion that they are "gaseous masses," giving light of similar refrangibility to that of nitrogen. A similar examination of Jupiter has led Father Secchi to the impression that his atmosphere has a far higher light-absorbing power than that of the Earth. He thus advances towards the proof required to what I have just mentioned concerning heat-rays traversing space without loss, and that the planets probably have atmospheres so constituted, according to their position in space, as to render the light and heat received in some degree equal for all. Through the application of spectrum-analysis to the planets, stars, nebulæ, and comets, we are led to believe that many of our views concerning their condition will need considerable modification. It has generally been believed that the moon possessed no atmosphere ; all evidence pointed always to that conclusion. Mr. Huggins, however, has observed that the spectrum of a fixed star undergoes a change at the moment before occultation by the dark limb of the moon characteristic of the passage of the star's light through an atmosphere.

Mr. Sorby has much improved on his method of spectrum-analysis by the microscope, and has successfully applied it to the detection of blood-stains.

Chemists have been, as usual, very active. The new metals with which spectrum-analysis has made us acquainted have been fully investigated, and various sources from which they can be obtained have been discovered. The new method of Mr. Crookes, of increasing the amalgamating power of mercury by the use of the metal sodium, has been rendered much more complete, and stripped of many of the objections which at first attended it. The priority of using sodium for this purpose seems, however, to have another claimant, a Mr. Wurtz, who, according to American authorities, was the first to use it.

Graham's theory of the diffusion of gases has been applied most beneficially to practical purposes. Instruments, not unlike aneroid barometers, are now constructed on principles first indicated by this great investigator, by which the presence of firedamp in collieries can be at once detected, and thus its dangerous effects provided against.

The most remarkable fact in the progress of geology in the western world seems to be Mr. W. Logan's discovery of a fossil zoophyte, of the order of Foraminifera, in rocks hitherto considered to have been azoic or devoid of life remains, being, geologically speaking, older than our Silurian and Cambrian formations, which have always been looked upon as the oldest of our sedimentary rocks. The fossil alluded to, is called the *Eozoon Canadense,* and was found in what are known to geologists as the Laurentian rocks of Canada.

The discovery of flint and other instruments, undoubtedly the work of man, in the drifts and in limestone caves, indicates to geologists the existence of the human race further back into time than our history reaches. These discoveries have been made in many parts of Europe and in the East. The implements are chiefly of flint or stone, and have frequently been found associated with the remains

of animals which have no longer an existence on the earth. These interesting discoveries, which have been greatly added to during the past year, have been widely discussed ; but further researches to clear up points now obscure and doubtful are needed before the best authorities will venture on any general conclusions as to the antiquity of man.

The discovery of bituminous shales and clays seems to be spreading over the whole world, and that in New South Wales promises to be a large source of wealth to those concerned in it.

In conclusion, gentlemen, I return for a moment to the affairs of this Society.

I congratulate you on what I believe to be the most important step during your last session, namely, that your council, aided by a small grant from Government of £175, have been enabled to print the papers which had accumulated for several years, and on their decision that for the future the proceedings shall be printed at short intervals. It will be fatal to our well-being and progress to let the works of your members lie by unpublished. I would urge you, therefore, to consider the carrying into effect this decision as essential, I would almost say, to the very existence of the Society. Nor must we always look to a Government grant for the means of doing so, and I believe, with economy and care, we shall be able to do so out of the revenue of the Society.

We cannot blink at the fact that this Society is numerically far less strong than it was some years back. It has been passing through an ordeal like that which all societies of this kind must inevitably go through in a new country. When the novelty wears off, then the work begins. We started as the Philosophical Institute of Victoria, but we grew ambitious, and obtained the privilege of styling ourselves the Royal Society of Victoria. There were far more aspirants

to the title of member of the Royal Society than that of member of the Philosophical Institute, but as time wore on many of these dropped behind. The annual amount of subscriptions dwindled down to a small and easily-managed income, till only those who cared about the Society for its own or for science's sake remained. And although I cannot say we are in a very prosperous condition financially, I still believe our Society is in a healthier state than it was in its apparently more popular days. The few that have stedfastly gone on with the work of the Society under the most adverse circumstances, are now being gradually reinforced by members whose motives for joining are, I believe, more substantial than those which influenced the many who have left our ranks. If we wish to succeed, and make this the foundation of what it may become in the future, a great, and perhaps the greatest, scientific body in the southern hemisphere, we must not sink its real objects—namely, the cultivation of science, literature, and art—in our efforts to increase our revenue by indiscriminately swelling our member-roll, or in attempting to make it too popular.

ART. I.—*On Ozone.* By R. L. J. ELLERY, ESQ., President of the Royal Society.

[Read 12th February, 1866.]

Many years ago Schönbein, of Basle, discovered the peculiar principle which is now known as Ozone; its chemical and physiological relations have been ably studied by that sagacious philosopher ever since, as well as by Andrews of Belfast, Tait, de la Rive, Becquerel, Baumert, and others, and although much mystery still envelopes the nature of this body and its effects, there is yet a large amount of evidence and experience concerning it, which, as far as I am able, I propose to lay before this Society. The general interest which attaches to ozone is, I conceive, principally due to the belief that it frequently forms a constituent of our atmosphere, and has a special influence in the animal economy, and, although it is questioned that this has been satisfactorily proved, there are few scientific men who venture to deny it. The want of satisfactory or absolute proof is owing, for the most part, to the difficulty of obtaining pure and free ozone in quantities sufficient for analysis and experiment, or in devising tests for its presence, which shall be incapable of being influenced in the same way by any other body as by ozone; but it will be useful to work as well as possible with the means at our command. I, therefore, propose to consider Ozone *that principle* present in our atmosphere which gives the reaction on iodide of starch papers known as ozone tests. For whether the reaction be due to ozone and ozone only, or not, or whether some more or less frequent reactions may not be due to nitric acid or some other highly oxydizing agents, will not matter, since the same physiological effects appear to be the result whenever the reaction happens. Much difference of opinion has at various times been entertained concerning the nature of this body. Schönbein at first considered it to be a peroxyde of hydrogen (HO_2) in the vaporous state. Baumert has recently suggested HO_3 as the

probable formula; but it has since been shown by Dr. Andrews (see his paper on Ozone in *Philosophic Transactions*, Vol. 146, Part I.) that hydrogen *cannot* form part of it. He sums up his elaborate researches with these words:— "Ozone, from whatever source derived, is one and the same body, having identical properties and the same constitution, and is not a compound body, but oxygen in an altered or allotropic condition." This view of the nature of ozone is the one, I believe, now generally adopted.

According to Dr. Apjohn, "Ozone is a gas of a peculiar odour, hence its name (ὀζω, *I smell*) having some resemblance to that of chlorine, diluted with much atmospheric air." Its specific gravity, according to Tait and Andrews, is four times that of oxygen, or taking air as 1·000, it is 4·4224. It possesses the greatest oxydating power of any known body, as at ordinary temperatures it destroys vegetable colours, corrodes organic structures, and powerfully oxydizes most metals. Like all other active oxydating agents, it decomposes iodide of potassium, and sets the iodine free, and this fact is used for the ordinary test for the presence of ozone. Free iodine dyes starch an intense blue; therefore, strips of chemically pure paper, dipped in a mixed solution of iodide of potassium and starch and dried, when exposed to ozone and then moistened, turn blue, with a greater or less intensity, according to the quantity present. Although this test is liable to similar reactions with several other substances, it has been found the most useful and certain, and is generally adopted.

Ozone can be produced artificially in many ways: by passing sparks of electricity through atmospheric air, or better through oxygen; in the decomposition of certain aqueous solutions by electrolysis; by the slow oxydation of phosphorus, ether, turpentine, &c., at common temperatures in atmospheric air; and by decomposition of permanganate of potash. The peculiar odour observed during electric discharges, especially of frictional electricity, is due to the ozone evolved. For experimental purpose the phosphorous and permanganate of potash modes are generally adopted. The evaporation and consequent oxidation of ether, however, appears, both from experiments of my own, and from a long series of observations of my friend, Dr. John Day, of Geelong, to be a very convenient method of ozonizing air. The effect of ozone, or ozonized air, on animal life, has formed the subject of investigation by many chemists and physiologists.

In 1851, Schönbein communicated to the Medico Chirurgical Society of London the fact that the inhalation of highly ozonized air caused a painful irritation of the lungs, a kind of asthma, attended with a violent cough. Schönbein, Schwartzenbach, Böckels, Desplats, and others, found that animals compelled to breathe strongly ozonized air died from affections of the respiratory organs, though Schwartzenbach considered the pulmonary symptoms were secondary, and that it was the nervous system that was directly attacked. Dr. W. Ireland, in the Edinburgh *Monthly Medical Journal* for February, 1863, states, as the result of his experiments:

1st. That ozonized air accelerates the respiration. 2. That it excites the nervous system. 3. That it promotes the coagulability of the blood, probably by increasing its fibrine. 4. Animals can be subjected to the influence of a considerable proportion of ozone for hours without permanent injury, but prolonged exposure always proves fatal.

Dr. Day, of Geelong, who has for several years closely studied the subject, more especially in connection with the prevalence of epidemics, and most especially diphtheria, informs me he has on several occasions subjected animals to air ozonized by ether, and that they always appeared to suffer from pulmonic disturbance. He told me that frequently, while experimenting with ozonized air, he has been attacked (to use his own words) with a "most delightful sore throat." On the other hand, it is stated, that in Algeria, where bronchial and lung affections are rare, the atmosphere generally contains a pretty full amount of ozone. The prevalence of cholera and other diseases of the alimentary system have been by many attributed to a deficiency of ozone in the air. This fact has not been corroborated by some experimenters; nevertheless, that the excess or defect of ozone in the atmosphere has some effect on the animal economy, more especially in weakened or diseased subjects, cannot be doubted. Further investigation, with a patient gathering together of statistics, will, I feel sure, be rewarded by a yet clearer trace of this mysterious influence. Years ago my attention was attracted by the marked changes produced in invalids, especially in those suffering from affections of the mucous membranes, by the sudden and great accession of ozone we sometimes get here when the wind, after blowing from the N. in summer for many days, suddenly shifts to the S.W. and S., more especially when accompanied by rain. I have

further noticed that when we get a high ozonic reaction over any extended period, that influenza has frequently been prevalent, and that a continued easterly wind, when ozone is always at its ebb here, is marked by a lowering of the tone in the system, indicating, perhaps, that a moderate amount of ozone is requisite to fully vitalize the blood. A systematic and continued course of comparison between the ozonic reaction and the prevalence of certain diseases, and especially the changes in such diseases, would, I think, be of good value. The meteorologist and experimenter should co-operate with hospital surgeons and physicians, and with the health officers of towns; the deductions that could be made after some years, perhaps months, of such co-operation could not fail to add much to our knowledge of the courses of disease, and perhaps to their prevention.

The power of ozone as a disinfectant and deodorizer is greater than that of any known body, and many plans are now proposed for ozonizing the air of hospitals and other places of like kind. The slow evaporation of water produces ozone in very small quantities; hence, the methods of adding aqueous evaporation to ventilation schemes is highly beneficial. But a larger supply would be necessary to effect the required purposes in some hospital and asylum wards, and therefore the mode of ozonizing air by the decomposition of ether would be the best.

I have been quite surprised at the effect of evaporating ether in ozonizing air, and of the powerful deodorizing action it produces. Dr. Day informs me that, in cases of necrosis, by the occasional sprinkling of a few drops of ether on the bandages, the dreadful stench which attends this bone disease is entirely obviated; and I believe a room could be ozonized to any extent by occasionally diffusing a few drops of ether by means of one of the perfumed jets, or by a fluid pulverizer.

To show the effect of sulphuric ether in producing ozone, I will just put a strip of Schönbein's test into a beaker, and then drop in a drop or two of ether. The paper has the full reaction in a few minutes. Appended to this paper are a series of observations extending over a period of about five years, namely, from March 1858, to December 1863. The results are given so as to show—

1st. The relation, if any, there may exist between the electric and ozonic condition of the air.

2nd. The amount of ozone registered at Melbourne, as

compared with Ballarat, Sandhurst, and Beechworth, in 1858.

3rd. The reaction in different seasons, and for day and night, in Melbourne, with other deductions. And a table showing the dates of the maximum of ozone with the state of weather which accompanied it; also, the dates of the minimum of ozone with the state of weather.

As regards the first part of the tables, namely, the relation of electricity to the presence or otherwise of ozone, no connection can be traced with any certainty during heavy rains. We certainly frequently get a maximum of ozone and a minimum of negative electricity, but this is not always the case.

From the second table, it will be perceived, that Melbourne has a less ozonized atmosphere than either of the three inland towns. This may be due by some means to the littoral position of Melbourne.

The third part shows, as does the preceding table, that most ozone is present at night at all four localities, and that there is more present in autumn and winter than in spring and summer. The tables of maximum and minimum clearly indicate that we get most ozone in Melbourne with wind from W., S.W., and S., especially with rain, and the least with the wind from S.E., E., N. The most occurs with S.W. wind.

I propose on an early occasion to supplement this paper with the results of our more recent observations and experiments, and if possible with some comparisons with the sanitary condition of the neighbourhood of Melbourne.

MEAN MONTHLY AMOUNT OF OZONE AND ELECTRICITY FOR THE FOLLOWING YEARS AND THE WHOLE PERIOD.

Months.	1858.					1859.					1860.					1861.					1862.					1863.					Mean for the Period.				
	Ozone, Mean of		Electric Tension.			Ozone, Mean of		Electric Tension.			Ozone, Mean of		Electric Tension.			Ozone, Mean of		Electric Tension.			Ozone, Mean of		Electric Tension.			Ozone, Mean of		Electric Tension.			Ozone, Mean of		Electric Tension.		
	Day.	Ngt.	Mean of Pos.	No. of Hours of Registration. Neg.	0	Day.	Ngt.	Mean of Pos.	No. of Hours of Registration. Neg.	0	Day.	Ngt.	Mean of Pos.	No. of Hours of Registration. Neg.	0	Day.	Ngt.	Mean of Pos.	No. of Hours of Registration. Neg.	0	Day.	Ngt.	Mean of Pos.	No. of Hours of Registration. Neg.	0	Day.	Ngt.	Mean of Pos.	No. of Hours of Registration. Neg.	0	Day.	Ngt.	Mean of Pos.	No. of Hours of Registration. Neg.	0
			pts.					pts.					pts.					pts.					pts.					pts.					pts.		
January ...	—	—	—	—	—	2·78	3·18	2·73	53	81	2·90	4·22	2·23	96	98	3·03	3·71	2·19	98	54	—	—	3·25	35	18	3·28	4·85	—	—	—	3·01	3·99	2·60	71	63
February...	—	—	—	—	—	2·27	3·32	2·67	76	77	2·63	4·35	2·21	124	113	3·67	5·52	1·23	37	172	—	—	2·95	43	54	3·80	5·71	—	—	—	3·09	4·73	2·27	70	104
March ...	3·32	4·17	—	—	—	2·68	3·36	2·72	57	61	3·57	4·17	2·39	49	72	2·50	3·91	1·31	38	183	3·65	4·72	2·44	19	40	3·64	3·14	—	—	—	3·23	3·91	2·22	41	89
April... ...	3·90	4·17	—	—	—	3·48	4·33	2·99	54	28	4·45	5·04	2·43	26	71	3·93	4·81	1·98	11	73	4·72	5·57	2·65	17	43	3·47	3·21	—	—	—	3·99	4·52	2·51	27	54
May	3·98	3·75	2·70	20	75	3·79	4·75	3·03	21	33	4·41	4·84	2·44	42	51	3·52	4·90	2·25	17	66	4·41	5·68	3·61	31	34	4·56	4·50	—	—	—	4·11	4·74	2·81	62	52
June	2·62	3·71	3·27	15	46	5·67	6·73	3·70	23	27	4·88	5·79	3·77	16	46	—	—	3·17	23	24	5·11	5·99	3·34	16	63	2·72	3·52	—	—	—	4·20	5·15	3·45	19	41
July	4·17	4·56	2·53	14	99	5·56	5·77	4·32	21	23	5·76	6·07	5·41	14	11	—	—	4·06	11	54	5·96	6·91	2·21	16	56	5·10	6·28	—	—	—	5·31	5·92	3·71	15	49
August ...	3·48	3·95	2·79	25	60	5·13	5·67	3·56	44	22	5·07	5·87	4·29	10	29	—	—	4·33	23	28	5·41	6·35	2·96	39	41	6·90	6·42	—	—	—	5·20	5·65	3·59	28	36
September	3·00	4·27	3·01	40	47	5·34	6·41	4·15	57	27	4·27	5·48	3·36	66	63	—	—	3·60	39	26	—	—	—	—	—	5·61	5·69	—	—	—	4·56	5·46	3·53	51	41
October ...	2·44	3·62	2·93	65	68	4·74	6·25	3·66	46	43	4·34	6·17	2·52	43	84	—	—	3·24	61	15	4·55	6·09	—	—	—	4·63	5·00	—	—	—	4·14	5·43	3·09	54	53
November	3·00	4·11	2·42	48	107	3·50	6·28	2·46	52	84	3·35	3·97	2·30	68	73	—	—	3·24	51	18	3·64	5·38	—	—	—	4·64	4·50	—	—	—	3·63	4·85	2·61	55	71
December	2·60	3·16	3·12	69	70	2·34	3·97	2·90	74	66	3·28	4·20	1·87	77	110	—	—	2·52	42	48	3·14	5·37	—	—	—	3·61	4·24	—	—	—	2·99	4·19	2·60	66	74
Means and Sums for the Year	—	—	—	—	—	3·96	5·02	3·25	578	572	4·07	5·02	2·95	631	821	—	—	2·77	451	761	—	—	—	—	—	4·33	4·75	Means for the period			3·96	4·88	2·92	559	727

COMPARATIVE TABLE OF MEAN AMOUNT OF OZONE AT DIFFERENT STATIONS.

MONTHS.	MELBOURNE.		BALLARAT.		SANDHURST.		BEECHWORTH.	
	Day.	Night.	Day.	Night.	Day.	Night.	Day.	Night.
1858.								
March	3·32	4·17	—	—	1·1	2·1	2·2	4·4
April	3·90	4·17	—	—	2·4	4·2	3·2	5·2
May	3·98	3·75	—	—	5·2	7·3	5·8	7·7
June	2·62	3·71	5·5	5·7	6·9	7·9	5·9	7·7
July	4·17	4·56	6·0	7·7	7·3	9·0	5·7	7·6
August	3·48	3·95	5·8	7·1	5·7	7·5	5·9	7·2
September	3·00	4·27	5·3	7·0	5·3	7·5	6·5	8·0
October	2·44	3·62	3·7	5·4	2·0	5·0	3·8	5·0
November	3·00	4·11	3·8	5·1	2·7	5·9	2·9	4·8
December	2·60	3·16	3·2	4·7	2·3	4·9	2·9	4·5
1859.								
January	2·78	3·18	3·4	5·1	2·0	3·7	4·0	5·0
February	2·27	3·32	3·8	5·3	—	—	1·0	4·0
Means	3·12	3·83	—	—	—	—	4·17	5·95

For Melbourne it was found that the ozonic reaction is smaller with east winds, slightly increases with N. and N.W. winds, and reaches its maximum when the wind blows from S. W. towards the east, gradually decreasing again.

With regard to the seasons, and day and night, the amount of ozone shows, with Schoenbein's test paper—

OZONIC REACTION

QUARTER.	DAY.	NIGHT.	MEAN.
Spring	2·81	4·00	3·40
Summer ...	2·55	3·22	2·88
Autumn ...	3·73	4·03	3·88
Winter	3·55	4·19	3·87
Year ...	3·16	3·86	3·51

There seems also a distinct variation throughout the day in the amount of ozone, in addition to that already shown by the day and night registrations.

Papers exposed during six hours give—

Between 6 a.m. and noon	1·59
„ noon and 6 p.m.	1·63
„ 6 p.m. and midnight	1·58
„ midnight and 6 a.m.	1·70

It appears that between the hours of 6 and 9 p.m. the amount is least, between 6 and 9 a.m. greatest.

The electric tension for the seasons is as follows—

QUARTER.	MEAN TENSION.	MEAN NO. OF REGISTRATIONS.	
	Positive Electricity. Parts.	Negative Elect.	No Elect.
Spring ...	3·12	159	186
Summer ...	2·64	242	248
Autumn ...	2·89	117	153
Winter ...	3·40	71	148
Year ...	3·01	589	735

The positive tension, being the normal state of atmospheric electricity, assumes its smallest value in the months of February and November, and its highest in the months of June and September, the range in the monthly mean amounting to 1·17 parts of division.

The electric tension is chiefly negative during hot winds, when clouds of dust are floating in the air, and during heavy rain; in the latter case the negative tension is frequently so great that vivid sparks may be obtained from the instrument.

The collation of the observations on the tension of positive atmospheric electricity gives the following results with regard to the means for the even hours throughout the year, showing a daily amplitude of two to three parts of division, the turning points of the same being at 8 h. a.m. and 3 h. p.m.

Midnight ...	2·97	Noon ...	2 13
2 h. a.m. ...	2·54	2 h. p.m. ...	2·72
4 h. „ ...	2·64	4 h. „ ...	1·92
6 h. „ ...	3·41	6 h. „ ...	3·03
8 h. „ ...	4·17	8 h. „ ...	3·52
10 h „ ...	2·84	10 h. „ ...	3·36

CASES OF MINIMUM OZONE,

Registered during 12 *hours' exposure, with attendant State of the Weather.*

Date.	Day or Night.	Amount.	Direction of Wind.	General State of the Weather.
1863.				
Jan. 1	Day	1.0	Wly.	Boisterous and cloudy.
2	,,	2.0	S.Wly.	Fine and pleasant; in the afternoon wind unsteady between S. and S.W.
6	,,	2.0	S.E., S., and S.W.	Fine and clear, and rather squally.
7	,,	1.0	N.Ely.	Fine and clear; warm wind; dense haze all round.
8	,,	0.5	Nly.	Hot wind; dense haze all round (like smoke).
8-9	Night	1.5	Nly.	Boisterous, squally; clear.
10	Day	2 0	S. and S.S.W.	Strong, cool breeze; dense haze all round horizon.
12	,,	1.0	S. and S.S.W.	Fine and pleasant, light squalls; dense haze all round.
16	,,	1.0	W., S.S.W. and S.	Cool and pleasant day; sky frequently changing.
17	,,	2.0	S.S.W. and S.	Fine, though rather cloudy.
17-18	Night	2.0	S.S.E. and E.	Cloudy during evening; after midnight clear.
18	Day	1.0	W., S.W., and S.	Fine and pleasant; strong wind towards the afternoon between S.S.E. and S.S.W.
21	,,	2.0	Variable and light, S. predominating	Beautiful weather, but very sultry.
21-22	Night	1.0	Nly.	Fine and clear and sultry; lightning all the evening, heavy gusts after midnight.
22	Day	1.0	N. until noon, after that S. and S.W.	Fine and clear, and very close.
27	,,	2.0	S. and S.W.	Dull and gloomy, clearing up towards the afternoon.
27-28	Night	1.0	S.S.E. and E.	Pleasant calm night; sky overcast.
28	Day	1.0	S.E. and S.S.W.	Fine, but cloudy, and sky very changeable.
31	,,	1.0	Variable and light, Sly. predominating	Calm, clear day; dense haze all round.
Feb. 1	,,	1.0	Nly.	Hot and calm, and very clear.
1-2	Night	0.0	N. and N.E.	Fine and clear, with heavy gusts of wind.
2	Day	2.0	N. and N.N.W., veering to S.W. at 5.32 p.m.	Hot wind and much dust; threatening clouds in S. at 5 p.m.
6	,,	1.0	S.W. and S.	Dull and cloudy; at 11 a.m. clearing off, afternoon fine and clear.
7	,,	2.0	E., S.E., and S., very light	Calm, dull day; dense haze all round.
10	,,	0.5	W., S.W., and S., very light	Dull, gloomy; at 11 a.m. clearing off fine.
12-13	Night	2.0	S.S.E. and calm	Very fine and clear, with heavy dew.
13	Day	1.0	S.S.W., very light	Fine and very hazy.
14	,,	2.0	S. and S.S.W., very light	Close and sultry; dense haze all round.
22	,,	1.0	N.E., and at noon veering round to S.W.	Fine, clear, and pleasant.
22-23	Night	1.0	N., N.W., and calm	Pleasant evening; towards early morning (3 a.m.) light rain.
Mar. 4	Day	0.5	S.S.W. and Ely., N. very light	Fine and clear day; lightning all evening.
5	,,	1.0	N.E., E., and calm	Warm, close day; distant thunder and lightning during the evening.
8	,,	1.0	W., S., and S.E.	Very fine weather; strong, cool breeze.
12-13	Night	0.5	S.E. and E., light	Fine and clear, getting overcast towards morning; heavy dew during night.

CASES OF MINIMUM OZONE—(*Continued*)

Date.	Day or Night.	Amount.	Direction of Wind.	General State of the Weather.
1863.				
Mar. 18-19	Night	0.5	Wly., S., and N.Wly., light.	Rain showers during evening.
20	Day	1.0	Calm, S. and E.	Fine and clear.
24	,,	1.0	N.Ely.	Fine and clear.
24-25	Night	1.0	N.Ely.	Fine and clear.
25	Day	0.5	N. and N.E.	Fine and clear.
28-29	Night	1.0	Calm and N.E.	Fine and clear; heavy dew.
29-30	,,	0.5	N.Ely.	Fine and clear; heavy dew.
30-31	,,	1.0	Calm	Fine and clear; heavy dew.
April 6-7	,,	1 0	N. Ely and calm	Fine and clear; heavy dew.
7	Day	1.0	Nly.	Fine and clear.
8	,,	1.0	N. and N.N.E.	Fine and clear.
8-9	Night	1.0	N.N.E. and E.N.E.	Fine and clear; heavy dew.
9	Day	1.0	N.E., S.W. and calm, very light	Fine and clear.
10	,,	1.0	N.Ely	Fine and clear.
12	,,	1.0	N.E. and Sly., light	Fine and clear.
13-14	Night	0.5	Calm	Fine and clear, with heavy dew during evening; fog after midnight.
14-15	,,	0.5	Calm and N.E.	Fine and clear, with heavy dew.
15	Day	0.5	Variable and light	Fine and clear, and sultry.
16-17	Night	0-5	S.S.W. and W., light	Rain showers after 10 p.m.; sheet lightning during evening.
20	Day	0.5	N.E., S., and N., very light.	Fine and pleasant.
20-21	Night	0.5	N.Ely.	Fine.
21	Day	0.5	Variable and calm	Fine and pleasant.
21-22	Night	0.5	N.Ely.	Fine.
22	Day	0.5	Variable and calm	Fine and clear.
May 1-2	Night	0.5	N. Ely.	Fine and clear.
9	Day	1.0	Variable and calm	Fine and clear.
11	,,	1.0	N.E. and Sly., very light	Fine.
June 1	,,	1.0	Variable and calm	Fine and pleasant; foggy atmosphere.
1-2	Night	0.5	Calm	Heavy fog.
2-3	,,	0.5	Calm	Heavy fog.
4	Day	0 5	Ely. and calm	Dull and foggy.
7-8	Night	1.0	N.Ely.	Fine and clear during evening, with heavy dew; overcast towards morning.
10-11	,,	1.0	Calm and N.E.	Foggy.
11	Day	0.5	N. and N.E.	Fine and mild; very hazy.
12	,,	0.5	N.E. and E.	Fine; dense haze.
13	,,	0.5	Calm	Very foggy.
13-14	Night	1.0	Calm	Very foggy.
14	Day	0.5	S.W. and S., light	Fine and pleasant.
15-16	Night	0.0	N.Ely.	Fine during evening; dull towards morning, with light rain and heavy mist all round.
16	Day	1.0	Nly.	Boisterous, with heavy, threatening sky.
18	,,	1.0	Nly.	Fine and mild.
18-19	Night	0.0	Calm and N.E.	Very fine, with heavy dew.
19-20	,,	1.0	Calm and N.E.	Very foggy.
20	Day	1.0	E. and Nly.	Foggy, but fine.
26	,,	1.0	Calm and N.E.	Dense fog.
27	,,	0.0	Calm and variable	Dense fog.
27-28	Night	1.0	E. and N.E., light	Very foggy.
28	Day	1.0	N. and N.E.	Fine and clear.
30	,,	1.0	N. and W.S.W.	Scattered rain at 10 a.m.; fine afternoon and boisterous; toward evening foggy.
July 12-13	Night	1.0	N.N.W. and calm	Dull, but fine; fog after 6 a.m.
Aug. 12-13	,,	1.0	E. and N.E.	Fine and clear; ice and hoarfrost.
14-15	,,	1.0	Calm and N.E.	Fine and clear; hoarfrost.
Sept. 13	Day	1.0	N. and N.E.	Very fine, but boisterous.
13-14	Night	1.0	N.N.W.	Fine during evening; dull and boisterous towards morning.

CASES OF MINIMUM OZONE—(*Continued.*)

Date.	Day or Night.	Amount.	Direction of Wind.	General State of the Weather.
1863.				
Sept. 25	Day	1.0	N. and N.E.	Fine, but boisterous.
28	,,	1.0	W. and N.W.	Fine, but cloudy and boisterous.
30-1	Night	1.0	E. and N.E.	Fine and clear; hazy.
Oct. 3-4	,,	1.0	S.E. and N.E.	Fine and clear, with heavy dew.
4	Day	1.0	N.N.E., S., and W.	Fine and cloudless.
4-5	Night	1.0	W. and N.E., light	Fine and clear, with heavy dew.
5	Day	1.0	N. and N.E.	Fine and clear.
6	,,	1.0	N. and N.E.	Boisterous and very warm; much dust.
10	,,	1.0	S.S.W., E., and v'ble	Fine and pleasant.
15	,,	1.0	E.N.E. and S.E., light	Fine; foggy.
16	,,	1.0	Ely. and S.	Very fine.
24-25	Night	1.0	Calm and Ely.	Fine and clear, with heavy dew.
25	Day	1.0	N.N.Ely.	Fine, but boisterous.
25-26	Night	1.0	N.N.E. and N.W.	Rain showers and distant thunder before midnight; heavy squalls towards morning.
Nov. 4-5	,,	0.5	E. and N.E.	Fine and mild, but dull.
16	Day	1.0	E.N.E. and Nly.	Fine, but oppressive; sharp gusts of wind and much dust.
21-22	Night	1.0	N.W. and S.	Fine.
23	Day	1.0	S.S.W. and S.W.	Fine and clear.
23-24	Night	0.5	S. in evening, N.E. towards morning	Fine and clear, with heavy dew.
24	Day	1.0	N.E. and N.	Fine and clear, and very hot.
24-25	Night	1.0	Nly.	Fine and clear, with heavy dew.
25	Day	1.0	N.Ely.	Dull and hot.
28-29	Night	1.0	S.E. and N., light	Fine and clear, with heavy dew.
Dec. 5-6	,,	1.0	W. and N., light	Fine; close and sultry towards morning with thunder towards E.
6-7	,,	1.0	Calm and N.E.	Fine; heavy rain shower at 2 a.m.; close and sultry towards morning.
7-8	,,	1.0	N.E. and N.	Fine and very close; dense fog towards morning.
9	Day	1.0	S.W. and S.E., light	Fine; dense haze all round.
19-20	Night	1.0	Calm and Nly., light	Very fine and clear, with heavy dew.
20 21	,,	1.0	S.E. and N.E., light	Very fine and clear, with heavy dew.
21	Day	1.0	Variable and light	Fine and very hot.
21-22	Night	1.0	Calm during evening, S.W. tow'ds morn'g	With slight dew.
22-23	,,	1.0	S.E. during evening, N.E. tow'ds morn'g	Fine and pleasant.
29	Day	0.0	Nly.	Hot and boisterous, and much dust.
29-30	Night	1.0	Nly.	Fine; light gusts of wind.
1864.				
Jan. 2-3	,,	1.0	S.E. during evening, N.E. tow'ds morn'g	Fine and clear, with heavy dew.
4	Day	1.0	Sly.	Very fine; evening close; sheet lightning from all points of the compass.
4-5	Night	1.0	S.E. during evening, variable afterwards	Close and sultry; rain showers early in the morning.
6	Day	1.0	S.W. and Sly.	Very fine; hazy all round.
7	,,	1.0	S.E. and Sly.	Very fine and pleasant.
7-8	Night	1.0	S.E. during evening, N.E. tow'ds morn'g	Fine, with heavy dew.
8	Day	0.0	N. and N.E.	Fine; very hot and sultry.
17-18	Night	1.0	S.E. during evening, N.E. tow'ds morn'g	Fine, with light dew.
18	Day	0.0	N.E. and E.N.E.	Fine and very hot.
18-19	Night	1.0	N.Ely.	Fine, and close and sultry.
21	Day	1.0	S.W., S., and E.S.E.	Fine and clear.
25	,,	1.0	N.W. and S.S.E.	Fine and very hot.
27	,,	1.0	W. and S.W.	Dull, but pleasant; threatening sky.
29-30	Night	1.0	S.E. during evening, N.E. tow'ds morn'g	Fine, and heavy dew.
30	Day	1.0	S.E. and S.	Fine and clear.

CASES OF MINIMUM OZONE – (*Continued*)

Date.	Day or Night.	Amount.	Direction of Wind.	General State of the Weather.
1864.				
Jan. 30-31	Night	1.0	Calm, and N.N.E. towards morning	Fine and clear, with heavy dew.
Feb. 1	Day	0.0	S., S.S.W., and calm	Very fine, with a strong, cool breeze.
5	,,	1.0	S. and S.E.	Fine and pleasant; very hazy.
14	,,	1.0	S.E. and S.S.W.	Very fine and clear.
14-15	Night	1.0	S.E. during evening, N.E. tow'ds morn'g	Fine and clear, with heavy dew.
15	Day	1.0	Ely. and S.S.W.	Very fine and clear.
15-16	Night	1.0	E.	Fine and clear, with heavy dew (earthquake at 2 a.m).
16	Day	0.0	N. and E.	Close and sultry.
16-17	Night	1.0	Calm and N.E.	Close and sultry and cloudy.
17	Day	1 0	N. and N.N.E.	Boisterous and very hot; sheet lightning in S.E. and S.W. during evening.
17-18	Night	1.0	N.N.E. and N.N.W.	Cloudy and squally; rain squalls at 6.30 a.m.
21	Day	0.0	S.S.W. and S.E.	Fine, but cloudy.
28-29	Night	0.5	E. and N.E.	Fine, with heavy dew during the night.
Mar. 1-2	,,	0·0	E.	Cloudy, and close and sultry towards morning.
7-8	,,	1.0	E.S.E. and E.	Fine and clear, with heavy dew.
8-9	,,	1.0	Variable and light	Fine and clear, with heavy dew.
9-10	,,	1.0	Variable and light	Fine, with dew.
10	Day	1.0	Ely. and N.	Dull and threatening and sultry.
10-11	Night	1.0	E. and N.E.	Close and sultry.
11	Day	0.0	N. and N.N.E.	Close and sultry; very hot afternoon, and threatening sky.
13-14	Night	1.0	Variable d'ng even'g, N. tow'ds morning	Fine and clear; very squally.
23-24	,,	1.0	Calm during evening, N.E. tow'ds morn'g	Fine and clear, with heavy dew.
24	Day	0.0	N.N.E.	Very hot; fine in the morning; at 3 o'clock, rain in S.W., thunder in same direction; at 4 o'clock, wind round to S.W., with heavy squalls and dense clouds of dust; at 5 o'clock, back again to N.N.E.
24-25	Night	1.0	N.E. during evening, S.W. in morning	Fine and clear.
28	Day	1.0	Variable and light	Fine and very hot.
28-29	Night	1.0	E. and N.	Fine and clear, with heavy dew.
29-30	,,	0.0	Calm and N.E.	Fine and clear.
31	Day	0.0	Nly. and E.S.E.	Fine and very hot; scattered rain at 6 p.m.; sheet lightning in evening.
April 11	,,	0.0	E. and N.E.	Very fine and clear.
11-12	Night	1.0	E. and N.E.	Fine and clear, with heavy dew.
18-19	,,	1.0	Ely.	Fineand clear, with heavy dew.
19-20	,,	1.0	Calm	Fine evening; heavy dew in the night; dark and gloomy towards morning.

CASES OF MAXIMUM OZONE,

Registered during 12 *hours' exposure, with attendant State of the Weather.*

Date.	Day or Night	Amount.	Direction of Wind.	General State of the Weather.
1863.				
Jan. 13-14	Night	10.0	S.W. tow'ds Midnight	Veering round to N.E., with steady rain.
23	Day	8.0	S. and S.S.W.	Thunderstorm during the evening.
24-25	Night	8.0	Calm	Constant steady rain and sheet lightning.
25-26	,,	10.0	Westerly squalls	Misty rain occasionally.
Feb. 2-3	,,	8.0	Sly.	Heavy lightning and distant thunder, scattered drops of rain.
7-8	,,	7.0	Sly., very light	Overcast sky.
17	Day	9.0	Sly.	Steady rain.
17-18	Night	10.0	Sly.	Steady rain.
18	Day	10.0	Sly.	Steady rain and strong squalls.
18-19	Night	10.0	Sly.	Heavy rain.
20	Day	10.0	S.W.	Misty rain.
26-27	Night	10.0	S.W.	Very strong.
27-28	,,	8.0	S.W.	Very strong, frequent sheet lightning.
Mar. 6-7	,,	8 0	S. and S.W.	Frequent sheet lightning.
11	Day	8.0	S.W.	Scattered rain.
15	,,	8.0	E.S.E. and S.E.	Light rain.
18	,,	8.0	Wly.	Heavy rain.
April 1	,,	8.0	N.Wly.	With thunderclouds and occasional rain showers.
5	,,	9.0	E.S.E. and S.	Misty rain.
19	,,	9.0	S.W. and calm	Very fine and clear.
24	,,	9.0	N. and W.	Heavy rain, with lightning.
24-25	Night	9.0	W.	Dull.
26	Day	9.0	Wly., S., and N.W.	Fine and clear.
May 3	,,	8.0	W. and N.N.W.	Light rain.
16-17	Night	8.0	S.E. and calm	Steady rain.
20-21	,,	8.0	N. and N.W.	Steady rain.
22-23	,,	9.0	Nly.	Fine weather.
June 5-6	,,	9.0	Nly.	Light rain
6	Day	9 0	Nly.	Light rain.
9	,,	9.0	Sly.	Squally, and misty rain.
14-15	Night	9.0	S.W. and S.	Dense fog towards morning.
23-24	,,	8.0	N.N.E.	Fine.
24	Day	8.0	W. and N.	Heavy rain.
July 6-7	Night	10.0	Sly.	With smart rain.
13-14	,,	10.0	S.W.	Occasional rain showers.
16-17	,,	10.0	S.W. and W.	Drizzling rain.
25	Day	8.0	N.N.W.	Fine.
30-1	Night	9.0	N. and Wly.	Boisterous ; thunderstorm, with rain and frequent lightning all night.
Aug. 1	Day	9.0	N.N.W. and W.S.W.	Strong gale, with rain squalls.
2	,,	10.0	W. and S.W.	Squally, with rain and hail.
2-3	Night	10.0	S.W.	Squally, with rain and hail.
3	Day	10.0	S W. and S.	Squally and showery.
4	,,	10.0	W.S.W. and S.W.	Squally and showery.
4-5	Night	10.0	W.S.W.	Squally and showery.
8	Day	10.0	N.W. and W.N.W.	Squally and showery.
17	,,	9.0	N.N.E.	Gloomy and showery.
18	,,	10.0	N. and E.	Showery and unsettled ; heavy thunder-clouds.
22	,,	10.0	W. and S.W.	Showery and unsettled.
26	,,	10.0	N. and N.N.W.	Boisterous and threatening ; rain and hail towards evening.
27	,,	9.0	N. and N.N.E.	Showery and squally.
Sept. 1	,,	10.0	N.	Heavy thunderclouds ; rain showers.
2-3	Night	10.0	S.W.	Showery.
3	Day	10.0	S. and S.W.	Showery and unsettled ; heavy low clouds.
10	,,	10.0	W. and S W.	Boisterous and squally ; light rain.
16-17	Night	10.0	S.W.	Rather dull and squally.
21	Day	10.0	S.W. and S.	Boisterous, and steady rain.
21-22	Night	10.0	S. and S .W	Boisterous, and steady rain.
Oct. 7	Day	10.0	S. and S.W.	Steady rain and heavy squalls.

CASES OF MAXIMUM OZONE—(*Continued.*)

Date.	Day or Night.	Amount.	Direction of Wind.	General State of the Weather.
1863.				
Oct. 12	Day	9.0	S. and S.E.	Dull, with gentle rain.
12-13	Night	10.0	S.	Incessant rain and heavy squalls.
13	Day	10.0	S. and E.	Squally and showery.
13-14	Night	10.0	W.S.W. and S.S.W.	Heavy rain.
17	Day	10.0	S.W. and W.N.W.	Incessant rain, with sharp squalls.
18-19	Night	10.0	W.S W. and N.W.	Unsettled, and rain squalls.
Nov. 1	Day	10.0	S.W. and W.S.W.	Heavy squalls, with rain and hail.
1-2	Night	10.0	S.W. and W.S.W.	Heavy squalls, with rain and hail.
2	Day	10.0	S.W.	Frequent rain squalls, with hail.
10	,,	9.0	S.W.	Fine and clear.
22	,,	10.0	S.W.	Violent squalls and heavy rain.
26	,,	10 0	S.W.	Rain, with little intermission.
27-28	Night	10.0	S.E. and E.	Fine and clear.
Dec. 10-11	,,	9.0	S.W.	Fine and mild, but cloudy.
13-14	,,	10.0	S.E. and S.W.	Heavy thunderclouds, with rain and violent squalls.
16	Day & Night	10.0	S W.	Squally and heavy rain.
1864.				
Jan. 9-10	Night	10.0	S.W.	Heavy rain showers.
26	Day	7.0	W.S.W.	Boisterous and showery.
Feb. 7	,,	10.0	N.W. and S.	Close and sultry, followed by heavy rain and thunder and lightning.
7-8	Night	10.0	W.S.W.	Boisterous and squally, with heavy rain showers.
8	Day	8.0	W.S.W.	Squally and misty rain.
23	,,	9.0	W.S.W. and S.	Fine and cold, but cloudy.
25	,,	8.0	S.W. and S.	Very fine and clear.
Mar. 2	,,	8.0	Sly.	Close and sultry, followed by a thunder-storm and heavy rainfall.
19	,,	10.0	S. and S.S.W.	Dull and squally.
25	,,	8.0	S.W. and S.E	Fine, but cloudy.
April 2	,,	8.0	W. and N.N.E.	Threatening and close, with distant thunder; towards evening, lightning and heavy rain.
6	,,	8.0	N.E. and N.	Dull and threatening; thunder and lightning with rain in the afternoon.
7	,,	8.0	S.S.W. and S.E.	Fine, but very dull.
8-9	Night	9.0	S.E.	Squally and rain showers since midnight.
9-10	,,	9.0	N. and S.W.	Very gloomy.
15	Day	9.0	N. and S.W.	Dull and threatening, with heavy rain showers.
16	,,	8.0	S.W.	Cold, cloudy, and unsettled, with slight rain showers.
21-22	Night	8.0	N.E. and N.N.E.	Fine during evening; cloudy, with light rain after midnight.
23	Day	8.0	N.W. and W.	Showery and unsettled.
23-24	Night	8.0	N.W. and N.	Fine and clear during evening; cloudy, with rain, towards morning.
24	Day	10.0	N. and S.W.	Raw and unpleasant weather, with steady rain.
24-25	Night	9.0	S.W. and W.	Cloudy and squally, with light rain showers.
25	Day	10.0	W. and S.W.	Cold, boisterous, and showery, with hail.
26	,,	8.0	W S.W. and N.W.	Cloudy, but pleasant, occasionally light rain showers.
May 7-8	Night	8.0	N.E. and S.W.	Fine and clear during evening; dull and cloudy after midnight.
9	Day	9.0	W. and Sly.	Fine and pleasant, though cloudy.
10-11	Night	8.0	N.W.	Fine, clear, and cold, with heavy squalls.
13-14	,,	8.0	N.N.W. and calm	Rather cloudy; drizzling rain towards morning.

NOTE.—In the months of January and February, the Ozone papers were exposed
From 6 a.m. to 6 p.m. for day
,, 6 p.m. to 6 a.m. for night.
While in the remaining ten months they were exposed
From 9 a.m. to 9 p.m. for day.
,, 9 p.m. to 9 a.m. for night.

Art. II.—*Grass Tree.* By Charles W. Ligar, Esq., Surveyor General of Victoria.

[Read 12th March, 1866.]

Mr. President,—The useful character of the information and the value it may ultimately prove to the Australian colonies, will, I hope, plead effectually for the omission of any formal notice of introduction to the Society.

With your permission, I beg to lay on the table specimens of the hitherto much neglected Grass Tree, or *Xanthorea.* Among them you will find a part of the outer husk or covering in its natural state, and small blocks of the gum prepared from the same.

The saucer contains the brilliant dark red varnish produced from it, while the two pieces of cedar-wood display its power as a varnish in adding lustre to cabinet work, giving a rich mahogany colour, most pleasing to the eye.

The two small bottles contain the yellow dye extracted by nitric acid, and called pieric acid. The bottle containing the dark semifluid mass is sugar, obtained from the heart or kernel of the tree ; and last but not least in importance, the two bottles which contain the colourless fluid, represent the spirit distilled therefrom. These articles speak for themselves, but in order to give an idea of their commercial value, I append statements from men well able to judge, and for which, and the specimens, I am indebted to Messrs. Strachan and Smith, of this city.

These gentlemen have erected at St. Ronan's, about sixteen miles south of Colac, suitable buildings, and it is in contemplation to introduce machinery for prosecuting the work.

It is computed that there is a sufficient number of these trees in the immediate vicinity of St. Ronan's, to supply five hundred plants a week for the next ten years.

The whole of the tree is utilised. The outer rind or husk is composed chiefly of gum, with a small admixture of woody fibre. The interior or kernel is about ten inches in length, by about six inches in diameter.

The first operation in the manufacture is to take off the outer husk, which is bruised and pounded, then placed on shaking tables and a copious supply of water allowed to run over it. The vegetable matter then washes away, leaving the pure gum. The trees usually weigh from eighty-four to

one hundred and twelve pounds. About one-fourth is pure gum. Trees growing in the neighbourhood of Queenscliff and other portions of the country where the soil is sandy, are said not to yield much gum.

The gum is said to have a commercial value in Melbourne of £30 per ton, which price has been offered by the oil and colour dealers. They purpose making varnish with it.

The gum is dissolved in spirits of wine, which as you perceive, is also a product of the tree. It is considered to be a very superior varnish, having a good body, great adhesive properties, is a rapid drier, and has, as I remarked before, a rich colour.

The gum is extracted at a comparatively small cost, so much so that it has been found it can be manufactured, carted, and shipped to England for £6 per ton.

The interior, or pith of the tree, is broken up. It is then subjected to hydraulic pressure, when a copious flow of the saccharine juice takes place. About twenty gallons to the ton are obtained. On distillation the twenty gallons of raw juice yield four gallons of proof spirits, worth at the lowest computation three shillings per gallon.

The gum, I have heard, has been known in the English market for some years, where a little of it has found its way from Sydney. It is there called "Black Boy Gum." It has been exported in a raw state, mixed with vegetable matter, and is worth at home from £6 to £7 per ton, and is supposed to be used to adulterate other gums.

In thus introducing to your notice one of the humblest members of our great forest family, one that asks only the most barren spots of the earth for its home, I do so with the hope that years of neglect may be followed by a long period of careful attention. I would before leaving the subject, observe, that out of the humblest looking products of the earth, men's greatest successes have been derived, and that we have now presented before our eyes, products capable, not only of ornamenting our wood-work and colouring our textile fabrics, but of actually sustaining life. The weary traveller may now claim this child of the desert as his best friend, and with slight appliances and little loss of time, obtain that which will enable him to prosecute his journey in safety.

Whatever may be the result of the actual commercial value of this tree, there has been, I hope, sufficient information collected to induce many to try the manufacture. This novel

industry is protected by no patent, nor is it surrounded by any difficulties that I am aware of. The figures relating to quantities have been collected from the gentlemen above named, but whatever measure of success or disappointment may be the result, it cannot fail to be highly interesting to this Society to see such a hopeless looking tree turned to so many useful products, through the aid of science, while to the mind bent on inquiry after the good and the useful, these remarks may convey a lesson never to despair, nor pass over what appears trifling and valueless at first sight.

Art. III.—*Gems and Sapphires.* By the Rev. John J. Bleasdale, D.D.

[Read 12th March, 1866.]

Mr. President and Gentlemen,—I trust I shall be forgiven on this occasion, as I have been on many preceding, for taking up a few minutes of the public time without having given previous notice. It is not always in my power to give notice of any little matter I may have to exhibit; and I prefer rather not to give notice than do so, and then disappoint the meeting. On the present occasion it was utterly out of my power to do so. The matter which I wish to bring before you to-night will not detain you many minutes; and that which forms the substance of it will, I trust, interest some and please all.

The very harmless and, to myself, pleasing recreation of collecting and collating the gem stones of our favoured country, has put, and will no doubt, from time to time, continue to put, in my way objects not unworthy of being recorded among the labours of this Society.

To-night I have in my power to bring under your notice a magnificent specimen of the green Sapphire (the Oriental Emerald), one of the very rarest of all gem minerals—so exceedingly rare, that Harry Emanuel, in his work just published, 1865, says of it: "The green variety (of Sapphire), or the Oriental Emerald, is the rarest of all gems, and is scarcely ever seen. In the whole course of my experience, I have only met with one specimen." Harry Emanuel is, of all living men, about the most likely to have met with specimens, if they were to be found in the trade at all.

You will have an opportunity of saying what you think of it yourselves; but for my part, I look on it as a most perfect gem, both as to colour, cutting, and size. It was found by a digger in North-east Gipps Land, and is believed to have been picked up about Donnelly's Creek. Unfortunately, Mr. Wright, of Geelong, who owned it in its rough state, forgot to ask particulars from the digger from whom he procured it; and the man has not been seen about Geelong lately. *In the rough state* it had the appearance of a roundish, flattened drop of rather Polish green glass, much the same in shape and colour, but smaller than the nodules of transparent green obsidian. Its true colour was greatly altered by the presence of two large flaws or "fouls," as lapidaries call them, one on each side, which reflected pale yellowish light right into it. In the rough state, therefore, it looked to great disadvantage. The removal of these "fouls" gave the lapidary, Mr. Spink, much trouble; while, at the same time, it very greatly reduced the size of the stone. On removing the outer crust a little bubble was seen some depth down, right in the face of the stone; and this had to be removed, thereby reducing the weight still further. It had, however, still abundance of thickness after this was taken out, and so it did not injure the gem. I mention this because this particular bubble, small as it was, greatly interfered with the true colour of the stone.

Cut and polished it now weighs rather more than five and three-quarters carats ($5\frac{3}{4}+$), and is the largest sapphire of any colour both found and cut in Victoria.

Shape.—It is now a perfect oval, well proportioned, single cut on the bizil, and with four rows of facets on the collet side. The cutting and polishing are unexceptionable.

The *colour* is a peculiar soft, but well-pronounced green of chrysoberyl cast, but yet with not so much of the apple green tint. In fact, the nature of the green is very marked and distinctive. The colour is also equally distributed all through it—a rare occurrence in sapphires. Its *lustre* and fire are exceedingly good, as you can see for yourselves, and as one might expect from a stone of its depth and absolute freedom from foul, flaw, feather, or speck of any kind. The work reflects great credit on Mr. Spink.

Its *hardness*—diamond being 10—is equal to = 9 +, and is the hardest stone ever cut in Melbourne. The specific gravity 4.001.

The *coefficient* of refraction has not yet been determined.

The two other specimens on the table (one cut, the other "in the rough"), are also from Gipps Land, and certainly from the district of Donnelly's Creek. There is a large piece, but very foul, in Mr. M. Stephens' fine collection, found in the Jim Crow Ranges.

ART. IV.—*The Volcanic Rocks of Rome and Victoria compared.* By JAMES BONWICK, ESQ., F.R.G.S.

[Read 12th March, 1866.]

Having visited above thirty volcanoes in Victoria, to the westward, as well as some in South Australia, I was naturally led, when at Home, to look at the volcanic districts of Europe. I had the pleasure of inspecting those of Auvergne, Naples, and Rome; besides, at the suggestion of Sir Roderick Murchison, having a ramble amidst the singular geology of the German Eifel. My state of health, at the time, did not permit of much walking, and so hindered my researches.

In the present paper I would omit all reference to Vesuvius, where I saw the flow of lava and *felt* a shower of ash, and would confine my observations to the singular parallel existing between the volcanic formations of our western country in Victoria, and that of Rome and its neighbourhood.

Rome, Eternal Rome, has indeed a charm to civilized man. So absorbing was its interest to me, that I was never more in Dreamland than there. I wonder now that the geological found a place in my mind. And if any weakness or error of description appear in my narrative, I must make this the ground of my apology to the Society.

What a history could one atom of Roman dust unfold! In the early ages hurled out of the caverned fire,—trodden by wild races without memorial or name,—entering the sturdy oak or cropped in grass by lowing oxen,—a fertilizer of the glowing Campagna,—a portion of the human frame—perchance of Cæsar,—and then a lowly dust again; how like the tale told of Rome itself!

In some respects, the budding maiden of Victoria, whose blushing beauties are yet unknown to Europe, presents a striking likeness to the long-revered and well-beloved matron of the Seven Hills.

In comparing the Tufa, or Volcanic Ash of the two places,

it may be stated, that both have the *tufa lithoide,* or consolidated stone ash. It is more abundant on the Roman than on the Victorian soil. As a building-stone with both, it has been employed in the most massive and important erections of Italy, and but little in this colony. Piles of it were reared in the Coliseum, and even used in the more ancient Cloaca. Climate and age seem to have no effect upon it. Here I have seen it in church ornaments at Belfast and Warrnambool. Saints' heads, effigies of sovereigns, dragons, and other primeval personages, inclusive of a volcanic John Wesley reposing on a monster at the Belfast chapel, have all been sculptured out of the Merri Creek tufa. I have seen some chimney-tops, and even substantial walls of stone, of the same material. A little skill is required in its manipulation. The strata being horizontal, and not so consistent as the Italian, should not be set up on the edge. A publican, near Mount Shadwell, had faced his house with this easily worked stone ; but having set it up perpendicularly, flakes have been so constantly falling that soon the various leaves will have flown out.

The Roman *tufa lithoide* is reddish brown in colour, with much pumice. Most of the Seven Hills contain it. The best quarry, however, is on the road to Albano, about nine miles from Rome. The Mamertine prisons, in which Paul and Peter are said to have been confined, are cut out of this rock. I found St. Elmo dungeons to be excavations in the Naples tufa. This ancient formation is a *Peperino,* being, as it were, peppered over. That used in the sewer, or *cloaca,* is a sort called *gabina.* The Tarpeian rock is very hard and red lithoide. The source of this tufa is not very apparent, and not, probably, in any of the existing craters. Sir R. I. Murchison has supposed that vents discharging ashes may have closed so as not to be distinguished now.

The more recent beds of tufa were, doubtless, thrown down from the existing craters upon the dry land, and are horizontal in position. The fresher ash contains hardly a trace of pumice, and is of a lighter colour. The *lapilli,* or small cinders, are in both sorts. Sand-shells and land-plants have been found in the newer sort. That north of the Campagna is whiter and contains pumice. The Peperino of Albano has fossil wood occasionally in it.

The *Pozzolano* of Rome is a particular sort of tufa, found in the ash-beds in small quantities, and highly prized for cements ; with the addition of a little lime it forms a good

material for submarine structures. I have examined the *Trass* of the Brohl Valley, near the Rhine, which has the same property. As we have not yet utilized our colonial tufa, I am not able to say how far we may produce a Victorian cement from that source.

As the *Pozzolano* was anciently called *Arena*, and obtained from the vast masses of tufa around Rome, some have erroneously supposed the catacombs to have been *arenariæ*, or sand-pits. I did not perceive any material difference between the ash of the catacombs and that of Victoria. Excavations could readily be made in our own, as the wombats discover; and as the material will not hold water, it would not be objectionable for a cemetery. The Italians term the catacomb-stone *tufa granolare*. It is like ours, to use the words of Daubeny, "dull and harsh to the feel, with an earthy fracture." It appears not to be so rich in minerals as the Peperino of Albano, which contains the garnet, nephaline, mica, Vesuvius angite, and dolomitic limestone. Dr. Curdie assured me he had detected much Vesuvianite in his ash-banks by the Curdies river, towards Cape Otway. The eruption occurring in a limestone country would account for the nodules of that rock found in the Roman tufa. I saw much of it in the ash of Mount Gambier, the neighbourhood of which is all limestone, and whose craters are hollows in that rock, blown out or subsiding during the convulsion.

Excavation in the tufa would afford admirable shelter. The shepherds of Italy, to this day, find relief from weather on the Campagna in the grottoes dug out in the ash. The ancient Etruscans used such for tombs. The Roman tufa-beds afforded graves before the Christian era, even to the Jewish colony of that city, though the catacombs became eventually the honoured and revered property of persecuted Christendom. As I stood in one of the dimly-lighted recesses, with my hand idly mingling the dust of martyred loved ones with the ashes belched from a roaring crater, and listened to a lecture by an Irish priest upon the recovery of the bones of St. Cæcilia, beside whose grave we were gathered, and whose anniversary of martyrdom was then being honoured, I could not but feel how rich with sacred and loving association was the tufa of Rome compared with ours.

There is a sort called *Pisolitic Tuff*, or Tufa. This has balls, or shot-like pieces, supposed to have been produced by drops of rain at the time of the fall. The calca-

reous ash, so common in Albano, is equally plentiful with us.

There is a great extent of territory covered with ash in the old Roman States. The sea-board of the Campagna beds extends ninety miles, while the breadth from hills to coast is about twenty-five. The Campagna in Rome, though a plain, is not without many undulations. The soil is very fertile. Once sparkling with a hundred cities, it is now almost a desert. Neglected culture has left undrained marshes to breed the dreaded malaria, which now reaches the walls of Rome. Let us hope that better days will see the tufa-fields of Rome covered with good farms and a healthy people.

The ash on the Victorian plains is darker than that of the Campagna, and more generally of the granolare than the lithoide character. Around the extinct craters, and on the plains at their feet, the formation reposes. To the south and west of Lake Corangamite and Lake Colac, many such spots may be seen; and so, also, passing from Ballarat to Portland, or Portland to Warrnambool. Excepting a few places, as Mount Franklin, little tufa is found upon our diggings. The later convulsions southward and westward have arisen, doubtless, since the auriferous period. Tower Hill, between Belfast and Warrnambool, shows the largest extent of this singular mineral, affording the finest farming land in the colony. A paddock of fifty acres of Mount Gambier ash soil has this year averaged fifty bushels of wheat to the acre.

The depth of the ash of Rome is considerable, and even greater than that which covered up Pompeii. In our colony it has been frequently found one hundred feet. At Woodford I observed great masses. It is ninety feet near Timboon. By Tower Hill, the bank is thickest on the eastern side, owing to the prevailing westerly breezes carrying the ash away. On the north side, a farmer, a quarter of a mile from the crater, told me it was eighty feet. Another, a mile off on the eastern side, sank one hundred and fifty feet in it for water, and gave up the work. Around Mount Gambier, the tufa varies greatly. In one part I saw it at least two hundred feet thick, but found it run out on the north side in a quarter of a mile. On another side, at an equal distance, it was forty feet. The Ash Peak rises hundreds of feet high. On the Pejark Marsh, between Mount Noorat and Lake Keilambete, it is evenly distributed. The tufa of Lake

Colongulac rests on the basalt. It was in clay thereon that the remains of the great marsupial lion were discovered. Black cindery sand is on the hard tufa of Lake Petrobe of Warrnambool. A red clay divides the ash of Woodford from the dark basalt beneath. The Moorabool tufa may have been thrown from the volcanic hills of Pentland, above Bacchus Marsh. The best ash-bed I saw westward was in a crater twelve hundred feet in diameter, eight miles from Mount Porndon, which the squatter had converted into a wonderful vineyard and garden.

But I may be pardoned some extracts from an account I wrote at the time of a visit to the ash-banks of our Tower Hill Volcano, as such a description found interest with the British Association in 1861, and as it truly depicts what I saw also in the banks of the Roman Crater of Lake Albano:

"Tower Hill Lake is seven miles round. The outlet is on the south-western side. On the east south-east side, where a quarry has been attempted to get stone for the church, the volcanic rocks were of great interest. Beneath the soil was a layer of small cinders, some assuming the appearance of calcareous, hard cement of white ashes. This rested on a dark blue flinty, splintery basalt, of a most unworkable character, traversed by singular seams of lime, and running down, as it were, not only under but beside the white ashes, and also by a bed of black, cindery conglomerate, not adhering, but like a loose mass of small cinders. Under the dark ashes I detected the layers of the common brown ash-stone or tufa, dipping thirty degrees west. Near the flinty basalt was a bed of argillaceous finger-staining earth, in association with a clinker-like cinder. The calcareous ash seemed everywhere running in white veins, through all other rocks. Curiously enough there were nodules of cherty limestone, which must have been pieces of the original limestone crater wall.

"Limestone rises, and a limestone quarry, are apparent on the western side of the hill, the tufa still lying on the lower lands immediately beside the limestone hills, which in one place were tilted twenty degrees to the west.

"A gem of a crater is seen on the eastern side of the Trigonometrical hill (inside of the lake). No grass was growing upon its fire-blasted walls. The rock was of compact basalt, green basalt, clinker, cinder, mammeloidal, convoluted, laminated, &c. There was one perpendicular block of cinder, thirty feet in height, possessing some remarkable aspects of volcanic agency."

Volcanic conglomerate is another product of the Roman hills. The circumstance under which we find it would lead us to suppose that it was much more abundant formerly, and that great masses have been washed off their old sites. A hill of this conglomerate of fine ash and cinders exists near Lake Bracciano, surmounted by a mediæval castle. The famous citadel of Tusculum, not far from Albano, was erected upon a rock of this substance, which itself stands on a stream of lava. There is a variety of this rock, much consolidated and studded with garnets, which is called by the Italians *Sperone*, the *lapis Tusculanus*. It was in the Neapolitan hills I saw a considerable amount of this formation.

In Victoria, the principal mass is on the Lawrence Islands, off Portland. The danger attending the visit, from the difficulty of landing, will not make it a popular resort for tourists. I found the base rock of very consolidated character. Part of it, consisting of ordinary tufa, and a dark coloured, marly-looking volcanic substance, ran to points one hundred feet and higher above the sea; and upon which, on different parts of the island, was the Cinder Conglomerate. While some of these *unrounded* cinders were minute in size, I noticed others a yard and more in diameter. A large piece of white felspar had somehow or other got wedged in the conglomerate.

A few years, comparatively, will see the last of this great curiosity of Victoria. The sea is constantly and successfully warring against so feeble and friable a material. When I was on the island, huge masses of the rock fell into the surging ocean. Gulche-ways pierce the fortress for the rushing tides, and resound with the scream of wild-fowl and the howling of the storm.

Having attempted an explanation of this formation some ten years ago, I may be excused, perhaps, an extract from that account, as I have not been able to repeat my visit:

"In the earthquake which tilted the Portland limestone westward of Cape Grant, it is not difficult to realize the action of a contiguous volcano. As no crater and no ashes are known inland, within fifty miles, it is highly probable that it was a submarine explosion. Some may imagine that it may have been that which occasioned the basaltic field, now recognized as Cape Grim, and the north-western islands of Tasmania; but from the prevailing westerly current, it may be presumed that the volcano was situated somewhere

south-west of the Portland Bay promontory. The period of its occurrence was a modern one, being subsequent to the limestone, our Tertiary stratum.

"It is certain that, from whatever cause originating, a considerable portion of the limestone upper crust was removed when lying beneath the water, as we found part of that space now filled with alternating sands and clay for fifty yards in depth, on the north-eastern side of Lawrence. Subsequently, then, to this deposition, itself so recent, was the submarine eruption of which we were speaking.

"As ashes rose from the vent and fell again into the waters, they would float on towards the limestone rocks, and in the waters of that shallow sea many of the pieces would gradually sink, and be mingled with the shifting sands. The absence of much abrasion would indicate comparatively quiet settlement. From the depth of stratum of the Conglomerate, it is probable that some little time elapsed during which fresh and continually occurring discharges from the submarine crater provided new material.

"There must have been some protection from the currents in the shape of projecting headlands, now washed away, else so frail a substance would have been swept away before consolidation. It is clear that no great time was allowed for the process, as we find no deposition upon the conglomerate. It is then in the highest degree probable that the whole coast line of the west rose almost immediately after such cinder subsiding; and it is equally probable that the last throes of all the volcanoes alluded to, were the agent of such elevation."

LAVA.

Though tufa is the principal volcanic product of Rome, yet lava, in its various forms, proceeded from even the modern craters. One sees it there under romantic associations. The castellated tomb of Cœcilia Metella, wife of Crassus, seventy feet in diameter, was built outside the walls of Rome on the very extremity of a bed of lava from Mount Albano. Streams are here and there met with on the Campagna. Not far from the wonderful St. Paul's Church, beyond the walls, I saw the quarries of the street polygonal blocks, the uncomfortable pathways of the city. The huge masses of lava forming the highways of the ancient Romans, are in most cases buried beneath the accumulated rubbish of ages.

But though I could not refrain from emotion as I trod the Appian Way, furrowed by chariot-wheels, it is probable that the lava pavement, along which Paul was borne a prisoner, lay still beneath me; such being the opinion of some learned antiquarians.

Black lava issues through the red tufa of Lake Bracciano, while a porphyritic lava pierces the limestone of Mount Catimi. Great masses of lava fill the camp of Hannibal at Monte Cavo. There is some very ancient trachytic rock in Rome. The Albano lava I found to be as varied as the ash. Some specimens were dark, heavy, and of a basaltic character, while others were light and scoriaceous. There were pieces like our own brilliant stone of Leura, sparkling with gems.

I have not heard of basaltic columns nearer Rome than Mount Radicofani, on the borders of Tuscany. The Roman lava is not so rich in minerals as that of Naples. The ancient rocks of Monte Somma are said to have a variety of above forty minerals. The lava shares with travertine and tufa the honor of erecting the glorious monuments of old Rome.

In Victoria, to the westward, the lavas are very varied in sort. The party-coloured, bright bunches of crystals, in the augitic lava, give Mount Leura the palm for beauty. The effect is very striking, with the setting sun illuminating the thin, lofty wall of the crater. I gathered blocks from the Green Hill of Ararat, having all the look of those from the Solfatara of Italy; while the green lava of Wickliffe is rare in Rome. Plain basalt forms the floor of our Western Plains, though scoria is the principal rock of our extinct craters. The decomposition of this rock may vary more from constituents than age. Some hills preserve their vitrified appearance, with sharply defined edges, while others lose their outline in the red earth of decay. The sea wall, near Portland, is so decomposed by the weather that it assumes the character of variegated clays, except the shot-like protuberances remaining from the amygdaloidal basalt. Some of our lavas, as the more consolidated basalts near Melbourne and Ballarat, and on the plains, are probably of submarine origin; while others, especially towards the south-western part of the colony, are clearly subaerial. We have here, as in Rome, limestone nodules mixing with our lavas. Such are seen at Mount Gellibrand, west of Geelong, as well as at Mount Gambier. Trachyte is at Wangoon,

Tower Hill, &c., as well as Obsidian, the volcanic glass. Phonolite is plentifully distributed.

Western Victoria presents more basalt than Rome, and we have many examples of prismatic or columnar basalt. At our Wannon Falls, 160 feet deep and 100 wide, the prisms behind the water, in their broken aspects, are like the shifting glasses of a kaleidoscope. The columnar reaches thirty feet upon ten feet of amorphous basalt at the Hopkins Falls. In measuring some of the rhomboids there, I found them ten inches by six. Reference need not be made to the picturesque Falls of Lal-Lal, the Coliban, &c. The depth of our deposits varies greatly. Near Belfast I was shown a spot where the basalt was forty-eight feet thick, while alongside, on a little flat, it was four feet.

Though unable to trace the sources of all of our basaltic streams, some may be distinctly indicated. The Wannon outburst ran out at the Smoky River, forty miles north-west of Portland. From the Anakies, two streams descended to the sea. The courses from Mounts Ecles, Napier, Rouse, and Clay, are well defined, and were very considerable in volume. The lava from Napier flowed fifty miles southward, and nearly parallel to the lines of Rouse and Ecles. There is very little lava about Mount Gambier. It is curious to find Mr. Surveyor Tyers referring to our basaltic plains, in 1838, after this manner:—"The nearer the coast they are considered more fertile. The extreme fertility of basaltic soils, according to geologists, is to be attributed to the carbonized materials produced during the igneous fusion of the rock."

There are, however, some points of dissimilarity between the two countries. There is nothing in Rome like our Mount Porndon, toward the Cape Otway country, which struck me as simply a pumice cone. When I ascended Mount Vesuvius, and only then, did I see its parallel. But there is another peculiarity in the country around Porndon—the Stony Rises. These petrified waves of lava I saw near the Darlot's Creek, Portland Bay, as well as near Lake Corangamite, and even, to a small extent, by Mount Fyans. These singular phenomena much astonished me. At Mount Porndon there were vast basaltic caverns, with chambers of immense extent. Under Mount Ecles and Mount Napier the ridges are like the Bay of Biscay surges, tumbling in all directions. In the Stony Rises, south of Corangamite, toward the Curdies River, a district fifteen miles by twelve,

I found the rock as *barriers;* being walls running hither and thither, from ten to forty feet in height. The early settlers had great difficulty getting their flocks through these basaltic defiles. They are truly like the Devil's Turnpike of Mexico.

Our lavas are not of equal age. Mount Franklin gives an interesting illustration. One stream can be traced from that crater, covering up the ordinary auriferous deposits, and furnishing the bluestone capping of hills, under which the Jim Crow miners tunnel. A breaking up of the golden deposit caused a fresh distribution in some of the neighbouring gullies: and over this newer stratum of gold a second, and therefore newer, stratum of lava has flowed. As has been before stated, a discharge of lava from Mount Noorat covers the ash from Lake Keilambete. At the Moonee Ponds some basalt is considerably younger, and of a different character, than that upon which it rests. At Portland, or rather the sea cliffs southward, I saw two lavas alternating with beds of Tertiary limestone. I gathered oyster shells, of size and sort different from any on our coast, beneath a huge pillar of prismatic basalt, while beneath me lay the Eocene limestone.

We might indulge our imagination as to the physical changes produced by volcanic actions in our western country.

There is a great sea with granite islets. A column of smoke arises from amidst the heavy billows. Rumbling noises are heard. Flames, like water sprites, leap up from the ocean. The crash of thunders and the flash of lightnings proceed from near the spot. Writhing forms of convulsed matter agitate the waters. There is a seething caldron beneath. Masses of viscid substance gurgle upwards, and fill the caves of the dark sea. A change follows. The convulsions cease. The blackened, rugged walls of the submarine crater are still and cold. The sea has brought shot-like pebbles and white mud to spread over the bottom. The land rises, and shakes off its liquid garment. The granite islets are the mountains of Ercildoun, Emu, and Cole, and the scene of volcanic fury is the grassy plain of Western Victoria.

CRATERS.

As I have already mentioned, we cannot trace the ash-beds of Rome to their craterform sources, as we can in Victoria. They may be beneath the bed of the Mediterranean, as the Bay of Naples now covers the stirring caldron from which Naples obtained its ash. One must go about fifteen miles to get a view of a Roman extinct crater. At Lake Albano we find ourselves in the midst of the Fields of Fire. An amphitheatre of hills spreads out before the eye to the north, north-east, and north-west. Monte Cavo, with its snowy cap, is half a dozen miles from Albano. Pila is of the same range. Priora, Campatri, and Porzio, belched out their fires more to the northward.

One of the distant craters is Lake Bolsena, sixty miles north-west of Rome, and twenty-six miles in circumference. Mount Cimini, over Viterbo, was on the boundary between Etruria and Rome, and long sheltered the brave Etruscans in its forests and ravines from the grasp of Rome. Lake Vico, near it, is supposed to have engulfed an Etrurian city. Lake Bracciano, the ancient Sabatinus, is twenty-five miles west of Rome, and twenty miles round. By it is a hollow plain, Baccano, once on a crater, ten miles round, and a source of ashes, which has even now a sulphurous pool in its centre. I looked over a similar volcanic hollow, called Vallariccia, near Albano, which Strabo said was formerly filled with water. Lake Nemi, a gem near Lake Albano, is nearly a mile across, and quite an oval crater.

Lake Albano was the particular object of my attention and observation. One of the Roman railways, *supposed* to go to Albano, landed me and the four other passengers by that train at a lone house on the wide and dreary Campagna, some two miles from the city. Reaching, at last, that town of poverty, uncleanliness, and idleness, I hastened by the Etruscan monument, raised to the son of Porsenna, and, untormented by guides, mounted 1450 feet above the sea, near to the Castel Gondolfo, the charming summer palace of the Pope, and looked down upon the gently rippling waters of Lake Albano. There I found groves of the oak, ilex, chesnut and stone pine, in their native homes, unsupplanted by the olive and the vine. On the inside of the slopes of the crater a very luxuriant vegetation impeded my way. The lake lay hundreds of feet below, two miles and a quarter long, by one and a quarter broad. An emissarium, con-

structed 2250 years ago, drains the overplus of water to the Tiber. Who that gazed upon that charming scene, gaily set off in autumnal tints, could realise the wild tempest of horrors which once raged there!

The Bank of Albano put me more in mind of our own Tower Hill than any other place. Both are gardens of delight. Both have seams of lava and lime in their tufaceous beds. There were the little caves answering to our wombat holes. There the jet black basalt pierced the ash-heap, as I had seen in our craterform lakes. There was the white-spotted mineral, so conspicuous in the bold Mount Clay of Portland. The bank was even higher than ours of Tower Hill, though not so long. The sides were not so precipitous as those of Mount Gambier, down which I dared not venture; nor did the water look so dark as that of the Devil's Inkstand. Lake Keilambete has walls as long and as oval, but not so elevated, as Lake Albano. One of the basins, not far from Timboon, has a great resemblance to the Roman one. Elingamite, in our southern stony desert, has few points of resemblance but its tufa sides. It put me more in mind of Mount Schanck in its basin appearance; though that Devil's Punchbowl, naked outside, is covered with fern on its inner and precipitous slopes.

The Albano water is fresh and deep. We, in Victoria, are favoured with fresh and salt water craters. Purrumbete, south of Colac, has delicious water. I listened to the splash of oars in that secluded region, and saw a fair lady rowing a pretty aboriginal child. Keilambete is quite salt, though I tasted of a fresh stream which gurgles out near the edge of the other water. The lake is two hundred feet deep. Bullen Merri, three hundred feet deep, is fresh, while its saline neighbour, Gnotuk, at a few yards distance, does not reach its level of surface by fifty feet. Lake Keilambete knows only a difference of eighteen inches between its winter and summer level; and lakes Terang and Wangoon, with fresh water, have little more. The depth of fresh water Lake Power, formerly known as the Devil's Inkstand, is two hundred and sixty feet, and is not, as was once supposed, unfathomable. The oldest inhabitant believed there was no bottom in our Lake Wangoon, near Warrnambool, until some one tried its bottom with a line.

Most of our Victorian craters which discharged ashes are converted into lakes, while those that discharged basaltic lavas are dry. The South Australian Schanck, although of ash,

contains no water. No high range is near, and the whole country around is of cavernous limestone, with its subterranean streams. Mount Elephant crater, rising nearly seven hundred feet above the plain, has occasionally water. I was struck with the luxuriant verdure there contrasted with the parched-up grass of the country around it.

Two of our craters resemble the Monte Cavo hollow, in which Hannibal had his camp. Our Mount Noorat is three miles across its shaggy basin, though scoria cones rise up within the crater, and a huge blister-like rock nearly blocks up the side through which the lava poured. It is 250 feet deep, and Leura 300; though the latter has been so shattered as to have but a thin shred of a wall remaining. The Roman craters were mostly broken down on the side exposed to Rome, having given that quarter the benefit of their discharge. Leura is fallen on the west side, Wangoon on the west, Napier on the south-west, Purrumbete and Noorat on the south and south-west. Mount Shadwell, which has, like Albano, discharged both ash and lava, has lost half its wall, and its reddened sides exhibit considerable oxidization, affording splendid soil for the farmer.

Napier, though one of our loftiest craters, 1440 feet, is but half the height of Monte Cavo, though just the elevation of Albano. Its crater discharged lava, which about there towers in fantastic forms. Its narrow ledge is gained with difficulty, and is not, like Cavo, adorned with ruins of an ancient temple; though within its drear basin the natives were wont to hold their most solemn moonlight corrobories. Superstition has her tales of the craters of Victoria as well as Italy, though priests have not sacrificed within their gloomy recesses.

Though not dignified as craters, there are several Roman hills of a scoriaceous or tufaceous character, which are rounded and closed at the top, but which may be more than suspected of disturbance in olden times. Such too are our numerous Mammeloidal hills to the west and north-west of Ballarat. Some, like Mount Cavern, have a portion of the top open, sufficient to indicate their former mischievous propensities. While a few exhibit a tendency to the crater of elevation, or blistering up from below, others show a collapsing after their explosion, as though glad to conceal the ghastly chasm from which such devastation issued. They are all, as far as I have observed, much older than the regular extinct craters, judging from the decomposed con-

dition of their framework, and the quantity of soil around their base.

AGE.

A year before I entered Rome a good and learned Irish priest had made a notable discovery there. His duties were at the San Clemente's Church, an edifice eight hundred years old, which you enter by descending steps. He had the good fortune to discover that this rested upon a much more ancient church of St. Clement, erected in the Imperial times. Further investigation led to the announcement that this primitive Christian house of prayer was raised upon a heathen fane, of vast proportions, whose walls stand there with blocks of volcanic Peperino eighteen feet in length. This is a story of Time.

Entering, then, upon the Age of the Volcanic Fields of Rome and Victoria, we must have recourse to some such process of descent as with that of San Clemente. We must go down to the Past.

We have more data for estimating the age of the volcanic monuments of Rome than of Victoria. Human appreciation of time is always insignificant. While standing beside the towering Coliseum, or keeping pace with the ghostly tread of legions on the Appian Way, the awe of distant years came over me. But long before Eternal Rome began her wondrous life, the fires that raised the soil were quenched, and herbs and flowers had healed the wounds of strife. It was fitting that the city which set the world in flames should rest upon flaming fields.

A few minutes before the iron horse carries the traveller along the tufa plains into Rome, a low range of hills may be seen. A railway cutting exposed a part of the diluvial base, and brought to our view some of the original inhabitants of the country. Bones of the elephant, hippopotamus, and rhinoceros, rolled out of the post Tertiary marls and sand. The blue-clay pits tell the same tale at the rear of the Papal Palace. The red Tufa Lithoide is near this formation. Over the tufa, and forming the summit of Monte Mario, are the Tertiary Mosaic beds of the Pliocene order, containing three hundred species of shells. Upon the celebrated Pincian Hill the remains of elephants have been discovered *under* a bed of travertin. Forty feet of fresh-water deposits lie on the summit of the hills. We have evidence of the existence of fresh-water lakes between

the hills; and the prodigious sewer, the Cloaca Maxima, is conjectured to have been constructed as a sort of emissarium to drain the last of the city waters.

The history of Travertin may help us in the question of time. At Tivoli the foaming falls and sparkling cascatella wear down the thick beds of travertin which repose *upon* the tufa. This rock was formed in an ancient lake, which may probably have been one of the craterform sources of the earlier ashes, but which became converted into a lake upon the elevation of the land after the eruption. Ages must have passed for soil of such quantity to be produced as to make the sweet valley of the Anio so tempting to those Greek adventurers, who sang their Attic songs at Tivoli before a Roman hut appeared.

When I saw both tufa and travertin united in the walls of the Temple of Vesta, which looked over the laughing waters at the Villa of Horace, I learned the alliance of earth and intellect, and felt that one purpose of Deity in raining showers of fire, and growing limestone hills, may have been that man might rear new forms of beauty, and transmit sentiments of elevated pleasure through those lithic works of thought.

The history of the volcanic process in Rome and its immediate neighbourhood may perhaps be thus described. Basaltic currents ran in very early times. Subsequently, tufa lithoide fell upon the earth, or mingled with the shells of the ocean. A subsidence followed; and during the tranquil ages the Mosaic Tertiary beds were formed. A fresh convulsion disturbed this serenity, and threw up hills which yet retain their capping of the ancient deposits, while all around was denuded by tumultuous waters. The sea now receded, and then came water formations of varyingly aged travertin, or sediment brought down by rivers. A highway may have existed from Africa to Europe, and the elephant, hippopotamus, and rhinoceros, may have travelled beside huge rivers that fell from Alps now lost in the Equatorial Atlantic. Carcases of these monsters were carried down by flooded creeks, and buried with the diluvium in the waters of Rome. The travertin stole quietly in when the ancient rivers were turned, and the Roman lakes were undisturbed by eddying streams. More tufa and lava followed. Another change lowered the level of the country, much of the diluvial deposit containing the elephants was washed away, and there was a renewal of the sedimentary process at the

bottom of these fresh-waters. The Sabine hills now burst forth with tremendous energy—earthquakes raised the Seven Hills of Rome, with their masses of volcanic rock, travertin, and elephantine beds—and then the vast accumulations of descending ashes, the present tufa granolare, were washed by heavy rains in all the vales around, and walled in the very Mediterranean. Again came repose. The Tiber, rolling from the Appenines to this sterile land of desolation, pierced its tufa beds, and carried the debris to the sea. The ash itself yielded to the softening influences of nature, and prepared for the granaries of Imperial Rome.

In discussing the age of our Victorian volcanic deposits, especially those tufaceous ones which are so similar to the Roman beds, I fear I can say but little, and that without the poetry and romance so associated with Italian geology. We live in a prosaic part of the world, unvisited yet by gentle fairies, or by rambling ghosts. But if no Horace has farmed our tufa, no Nero has tortured in our tufaceous caverns. Though our ancient songs have been but the chants of lubras at corrobories, our lava plains have not been bathed with tears and blood as the fair Campagna.

The fossil marsupial lion, found in connection with our ash-beds to the westward, most certainly takes us far back into the past. It is a long day since the kangaroo and wombat, whose gigantic size and curious formation so astonished the English geologists, were laid by Lake Colangulac, or washed into the Wellington caves of New South Wales, where Major Mitchell found them thirty years ago beneath the red earth. We have no Carnivora now of any species, allied with a monster that played such havoc in the old Victorian forests among the gentle kangaroos, four yards in height. Yet these were the creatures inconvenienced by our descending ash showers. I found the tooth of a primitive shark in a deposit at the edge of the superimposed tufa.

Our oldest inhabitant has lived here but thirty years. In Italy there are records of nearly as many centuries. We may, therefore, with grace yield the palm of superior antiquity of volcanic action to our mistress on the Tiber, though our tufa is as thick as the ash of the Catacombs, and our bluestone as hard as the blocks of the Appian Way.

As to our basalt—that successive streams flowed over the same spot is a fact well known to our enterprising diggers, who pierce four such strata at Ballarat. Such are found,

however, to be very similar in mineral character, with no great apparent pauses between the eruptions, which came doubtless from the same centre.

If, as most think, our alluvial diggings are of recent Tertiary times, the superimposed basalt may be more modern than many others. Yet even there has been time for soil for a forest clothing. I have elsewhere alluded to the deep masses of calcareous rock between two beds of Portland basalt. The existence of hundreds of feet of rock, consisting chiefly of the debris of a coralline sea, would assume considerable antiquity for the first basalt.

In New South Wales the basalt is very common in the coal-fields. Count Strzelecki gives four distinct epochs for the Tasmanian basalts. When standing by the celebrated opalized tree, near the Derwent, I observed that deep beds of basalt lay upon a broad sheet of greenstone. If Victoria differs from Tasmania in its rich deposits of ash, it is inferior to the island beauty in the relative extent and variety of its more consolidated volcanic products.

In conclusion, if we have no *past* glories of greatness, like Rome, to associate with our Victorian volcanic rocks, let us build up with them a bright and happy *future*. A numerous and gladdened peasantry may till our tufa fields. Works of material progress, structures of architectural beauty, haunts of science and the arts, schools of learning, fanes of piety, and homes of free and virtuous citizens, may stand before our children, and our children's children, in the everlasting basalt of our rocks—a type of that stability of being found in truth, in peace, in love.

Art. V.—*Experiments and Observations on Absorption.*

By George B. Halford, M.D., Professor of Anatomy, Physiology, and Pathology, University of Melbourne.

[Read 11th June, 1866.]

I purpose to lay before the Society the results of some experiments upon the absorption of colouring matters by the living body. It is well known that absorption takes place readily when fluids are thrown into the loose connective tissue beneath the skin, or into the serous cavities, as also from the great mucous tracts extending from the eyelids to the lungs, and from the ears to the anus. From the skin also,

especially where thinnest, absorption takes place. By the term absorption, I mean the simple passage of fluids, without retardation for the purposes of assimilation or rejection.

In order to trace the passage of these fluids, I have used the aniline dyes, viz., magenta, mauve, blue, green, cerise, and yellow.

Dr. Roberts, of Manchester, first called the attention of the Royal Society of England, Feb. 18th, 1863, to the wonderful tinting power of magenta, and to the remarkable fact, that if a small quantity be added to a drop of mammalian blood, a minute spot, coloured with the dye, appears at some part of the edge of the disk. Subsequent experiments with tannin resulted in his producing in the red corpuscle of mammals, birds, reptiles, and fishes, "a bright, highly refractive bud or projection on the surface." These he called "pullulations." In the *Quarterly Journal of Microscopical Science* for July 1863, is a *resumé* of his discoveries.

I have long since verified all that Dr. Roberts has stated, and have used magenta dye very extensively in histological inquiry. The effect of the direct application of a solution of magenta to a drop of human blood is, besides producing the pullulation in the corpuscle, to colour the nucleus or contents of the white corpuscle. These white corpuscles are not all of the same size, some containing a single nucleus, others two, three, four, or more. The lymph corpuscle smaller than the white corpuscle, is also deeply tinged, and there is apparently a transitional form of the lymph corpuscle towards the white; and lastly, granular matter deeply tinged.

The blood of the bird or frog has the nucleus of the red corpuscle deeply dyed, whereas the white corpuscles are uncoloured.

Moreover, magenta deeply tinges the following elementary structures:

Corpuscles of lymph and chyle, contents of duodenal epithelium and mucus.

Nucleus of all forms of epithelium.

All young cells.

Envelope and nucleus of some forms of fat.

Nucleus of tendon and of unstriped and striped muscular fibre.

Cell and nucleus of cartilage.

Cell and nucleus of bone, and of red marrow of bone.

All forms of nerve cells.

Nuclei of capillaries and connective tissue.

Having ascertained that applying magenta to the conjunctiva produced no irritation, I hoped that its gradual absorption into the system might reveal to us certain particles and hitherto ill-defined forms of structure, and that possibly the passage of such particles (germinal matter of Beale, histogenetic molecules of Bennett), might be traced from one part of the body to another; but I must say that a great deal of labour has brought me a very little way on, still I am not without hope that I may yet lay something more definite on this subject before the Society.

It matters not whether these dyes are injected into the peritoneal cavity or beneath the skin, they almost immediately make their appearance in the urine. Very little inconvenience attends the operations, and even after injection into the pleural cavity life is not endangered. Thus I have injected the same animal or bird eight and ten times; if care be not used, however, inflammation is produced, most probably from the point of the instrument wounding some of the viscera. In the two cases where death resulted, the peritoneal cavity was found full of *uncoloured* serum and lymph, at the same time that the dye had disappeared from the urine before death.

We have now to determine by what route the dye passes from the abdomen or from beneath the skin to the kidneys; certainly not directly. Knowledge familiar to us all is against such a view. To appear, therefore, in the urine, it must have been brought from the heart by the arteries to the kidneys. Our most direct course is to examine the contents of heart soon after injecting the dyes. For this purpose I performed the following experiments:

Experiment 1.—A frog was injected beneath the skin with equal parts of blue dye and water. Four hours after I exposed the heart, *without disturbing the pericardium*, and saw the blood deeply dyed, flowing into and out of the heart with each relaxation and contraction of the ventricle. The blood in the femoral artery was also dyed, as were all the tissues more or less.

Experiment 2.—Another frog was injected with yellow dye. In twenty minutes, by the same proceeding as above, the circulation of yellowish blood was seen. All the tissues slightly tinged.

Experiment 3.— Magenta dye similarly used, and magenta-coloured blood seen circulating.

Experiment 4.—Green dye produced no effect. I found it unabsorbed beneath the skin.

Having traced these colours from beneath the skin to the heart in the frog, rendered it unnecessary to perform the same experiments with a dog or fowl, in either of which it would be more difficult and perhaps impossible to see coloured blood at the centre of the circulation, through the denser fibres of the heart; whereas, in the frog, the delicate structure of this organ permits of the colour of the blood being easily seen through it. This is a very beautiful experiment, and I recommend it to the notice of physiologists as showing clearly one form of absorption, and, *provided the pericardium be not opened,* the heart's action. We have now to consider by what means the dyes reach the heart.

It has been before stated that the lymph and chyle corpuscles are readily and deeply dyed by magenta, and as by injecting into the peritoneum the dye is brought into close proximity to the lacteals, and hence most liable to absorption by them, I performed numerous experiments upon dogs and fowls, and having killed them as soon as the dyes appeared in the urine, laid bare the the thoracic duct, as I had previously the heart in frogs, to see, its coat being transparent, if its contents, the chyle, were coloured.

In no instance could I detect the colour of the dye used, either in the thoracic duct, lacteals, or lymphatics.

It is reasonable to suppose that had the dyes been absorbed by the lymphatics and lacteals, and not by the veins, they would have been as readily seen in the thoracic duct as they had previously been in the frog's heart, or even more plainly.

Leaving for the present what I have to say of the blood, I pass to the microscopic examination of the other fluids and tissues.

I have already mentioned the dyes employed, and it only remains to state, that they were of all degrees of concentration, from their undiluted condition to the proportion of one part of dye to twenty of water. Generally they were injected into the peritoneal cavity, or beneath the skin, and once into the cavity of the pleura. Sometimes their temperature was raised to that of the blood of the animal; at other times they were injected cold. The dye usually appeared in the urine a few minutes after injection, and half an ounce of the dye—a quantity sufficient to make a gallon of ordinary dye—*passed entirely out of the body in*

twenty-four hours As might have been expected, absorption and excretion were more rapid in the fowl than in the dog.

It would be tedious to read the notes of all the experiments, but any one wishing to do so, may at any time see them.

The following fluids and tissues of animals, frogs, birds, and dogs, were microscopically examined when it was believed that most dye was present in the body :

Chyme, chyle.
Fluid of mesenteric glands and lymphatics.
Voluntary and involuntary muscular fibre.
Muscular fibres and lining membrane of heart.
Brain, spinal-cord, and nerves.
Cartilage, bone.
All epithelial structures.
Liver, lung, spleen, and kidney.
In none could I detect the slightest evidence of colour.

We are then satisfied that although the dye permeates every atom of the body, excluding only the densest tissues, its presence cannot be discovered microscopically in any. Is it then absorbed by the blood discs, or does it become an undistinguishable part of the serum ?

Microscopical Examination of the Blood.

Many difficulties lie in our way, some of which may be considered insurmountable.

1st. The evidence of colour is very untrustworthy, depending as it does upon the power of appreciation of the observer, and it becomes much more so when the subject of observation is a microscopic particle, something requiring a quarter inch objective to discern and describe. It varies also with the colour of the light transmitted, as we use a white cloud, blue sky, or light from a lamp.

2nd. Too much stress must not be laid on the very minute quantity of colour necessarily present in any particle so small as a blood corpuscle, for the dye is readily visible when really absorbed, in particles very much smaller.

3rd. By far the greatest difficulty lies in the diffracting power of the red corpuscles, whereby the rays of light are made to interfere, and this is especially the case when the blood having been first dispersed with the point of a scalpel over the slide, is allowed to dry. It constantly happens that

they are seen separated at equal distances from each other, and being perfectly circular, show the most beautiful prismatic colours when *attentively* examined with a good quarter inch objective. The colours change with the distance of the objective from the discs, exactly as they do when a piece of perforated zinc held in a beam of diverging light is looked at through a lens, and the distance varies between the zinc and the lens. The appearances presented I have here sketched, and I wish to add, that I am indebted to my colleague, Professor Wilson, for a great deal of information on this curious subject of interference, and to Mr. Ellery, for having taken a great deal of trouble to examine many specimens of blood.

4th. It follows, that the observer in his desire to succeed, can find almost any colour he is seeking for, and not in the blood-disks alone, but in those microscopic globules at times so abundant in the blood, according as the distance between the disks and the objective is varied; and as the red is the broadest of these interference fringes, it and its complementary colour green, are most readily seen.

I have then to state, that a drop of blood from an animal injected as above, gives no certain evidence of its presence in either the white corpuscle, lymph, or chyle corpuscle; at most they are all very slightly tinged of whatever colour has been injected. Thus, the red spot seen in the centre of the dried disk, when in focus, is more brilliant when majenta has been injected, but more than this I cannot say. I have never seen the nucleus of the white and allied corpuscles tinged, although I have experimented upon sucking animals, in whose blood they are so abundant.

It had been found by Dr. Roberts, that after the formation of the "pullulation," if magenta was applied, "the projections were found to take the dye strongly, and especially the vesicular body within the hood."

In order to determine whether the living corpuscles would be similarly affected, I injected half an ounce of tincture of galls mixed with one and a-half ounce of warm water into the peritoneal cavity of a fowl. Within a very few minutes our "feathered biped" showed symptoms of intoxication, and for the space of an hour was ludicrously drunk, reeling and staggering about, but rapidly recovered.

During all this time he was passing tannin in his urine, as was evidenced by testing with a solution of iron. It soon, however, disappeared both from the blood and urine.

Microscopical examination of the blood showed nothing of the pullulation, nor did the subsequent application of magenta reveal any previous action of the tannin.

A similar experiment was performed upon a dog. It would have been impossible to swear in a court of justice whether the dog became drunk or not; having four legs he managed to balance himself tolerably well, but, as before the experiment he was very savage and snappish, and afterwards was very sociable, familiar, and waggy-tailish, I have little doubt that the alcohol floated to the surface those weak points of his character which his habitual beverage kept usually suppressed. Be this as it may, the blood showed no evidence of the action of tannin.

These experiments, although failing in the purpose for which they were commenced, show, if this were now necessary, the facility with which fluids external to the blood-vessels permeate them and are finally removed from the system; absorption taking place principally through the blood-vessels, and not evidently through the so-called but badly-named absorbents, for in no instance were the contents of the thoracic duct tinged. No doubt whatever exists of the absence of the dye in the thoracic duct, whilst its presence first in the blood, then in the urine, is undoubted. Again, we are led to admire the equal facility that exists for the removal of matters absorbed into the blood by the kidneys, a power that is truly marvellous, preserving in all these experiments the entire health of the animal, and preventing even their own epithelium being coloured.

During the absorption of the dyes from the peritoneal cavity, in two or three instances, there was a simultaneous accumulation of colourless serum in the same cavity, a true endos and exosmosis occurring in the same membrane and same vessels at the same time (?)

The foregoing observations are deduced from upwards of one hundred experiments.

I now proceed to the results obtained by injecting solutions of ferrocyanide of potassium and perchloride of iron into the peritoneal and pleural cavities, stomach, and beneath the skin.

Fodera, in 1824, (see Milne Edward's "Leçons sur la Physiologie,") by injecting an infusion of galls into the pleural sac or urinary bladder, and at the same time a solution of sulphate of iron into the peritoneal cavity, found a black precipitate in the thoracic duct and other parts of the body.

In other experiments he substituted for the galls a solution of ferrocyanide of potassium, and succeeded in discovering prussian blue in the thoracic duct and elsewhere.

Again, one of our best workers in science, Mr. Ralph, of Kew, near Melbourne, in a paper read before the Medical Society of Victoria, December 6th, 1865, states, that when prussic acid has been either swallowed or inhaled, minute particles or films of prussian blue, may, with the aid of the microscope, be detected in the blood; and along with these, in very many instances, he has observed bodies resembling starch-grains, which polarize, and upon the addition of iodine turn purple. His theory is, "that the prussic acid is more or less nutralized in the blood by the iron present in it, and in proportion to the iron thus withdrawn, there is so much starchy matter set free."

My own results are as follows:

Experiment 1.—At 11, a.m., March 28th, 1866, I injected a solution of ferrocyanide of potassium into the peritoneal cavity, and a solution of perchloride of iron beneath the skin of the back of a fowl.

Purging and passing of urine soon followed. On testing the urine for iron, none was discovered, but abundance of the ferrocyanide of potassium. The tests used were—for the iron, tincture of galls and ferrocyanide; for the ferrocyanide, perchloride of iron. No amorphous prussian blue was found in the blood, but on evaporation numbers of minute crystals were observed with the microscope, some green, many "darkly, deeply, beautifully blue, as some one somewhere sings about the skies." As there are both yellow and blue ferrocyanide of potassium, it was impossible at this stage of the experiment to speak with certainty as to the presence of prussian blue in the blood.

At half-past 12, p.m., made the bird swallow four ounces of the solution of perchloride—seemed to like it. Urine and blood again examined—result as before.

At 9 o'clock, the following morning, the urine gave no trace of either iron or ferrocyanide of potassium, and the bird was quite well. It was now killed.

The contents of the thoracic duct were to the naked eye colourless—no appearance of prussian blue—no evidence either of iron or ferrocyanide upon using the ordinary tests. A drop drying on the microscope yielded the same undetermined crystals as the blood.

Upon touching any part of the peritoneal cavity with a

solution of iron, not the slightest reaction took place; so also when applying a solution of the ferrocyanide to the part beneath the skin, where the iron had been injected, no reaction occurred. In none of the tissues were either found in a free state. The alimentary canal, which had contained iron a few hours before in such abundance, now gave signs of none.

From this experiment we infer, that in twenty-three hours the iron had either entered into very stable combinations in the body, or had passed out of the body in the urine in equal stable combination; or uniting with the ferrocyanide, was actually present in the tissues and fluids in the form of the minute * blue crystals before spoken of as seen in the blood and chyle.

It is not to be supposed that these salts are absent from a tissue because they do not answer to ordinary chemical tests. The spectroscope must be used. Here is an illustration of its use: Mr. Bowman, the distinguished occulist and physiologist, had a patient with double soft cataract; she took twenty grains of carbonate of lithium, seven hours after which one eye was operated on, and the lens removed. The minutest portion showed abundance of chloride of lithium in the spectrum. Seven days having elapsed, the other lens was removed, but not a trace of the salt could be detected. This was a part of a series of experiments recently made by my former teacher, Dr. Bence Jones, to whom I am much indebted for instruction in what may be termed clinical chemistry.

Experiment 2.—One and a-half ounce of solution of perchloride of iron were injected into the peritoneal cavity, and one and a-half ounce of solution of ferrocyanide of potassium beneath the skin of the back of a dog.

At intervals during the succeeding twenty-four hours, I frequently examined the blood for free iron and ferrocyanide, but found none; but beneath the microscope crystals on evaporation, as in the blood of the cock.

Twenty-six hours after the injections a large quantity of urine was passed, to some of which, when a drop or two of perchloride of iron was added, a large quantity of prussian blue was formed. No trace of free iron. A drop of the urine evaporated on a slide showed beneath the microscope an

* When I use the word "minute," I mean something sensibly much smaller than a human red blood-corpuscle.

enormous quantity of bright blue particles. Another portion of the urine was taken, and evaporated in a white porcelain dish; towards the end of the process a dirty blue residuum was formed; to this distilled water was added, and gentle heat of a warm-bath applied. Much organic matter was thus removed, the residuum having all the appearance of prussian blue. Examined with the microscope there were no longer the doubtful crystals, but true amorphous prussian blue.

Seven hours after, more urine just passed was examined, but not a trace of either the ferrocyanide or iron was detected, and upon evaporation no prussian blue was obtained.

Thus, then, in twenty-four hours were the kidneys enabled to remove this large amount of iron and potash from the body; a result agreeing with what we saw in the last experiment with the cock, and with all the previous ones with the aniline dyes.

Experiment 3.—Three days after this, the dog being perfectly well, on again tapping the abdomen, I drew off some serum slightly tinged with blood. In this I sought to detect some of the iron I had three days previously injected; not a trace was discovered. I again threw in one and a-half ounce of solution, perchloride of iron, raised to 100°F., and one and a-half ounce of a saturated solution of ferrocyanide of potassium of the same temperature. The former into the peritoneum, the latter beneath the skin of the back.

During the succeeding twelve hours, the blood yielding crystals as before, the urine was several times examined, giving still more abundant evidence of the presence of the ferrocyanide, but not of the iron, until evaporation, when the residuum being washed, prussian blue, this time in great quantity, was obtained. Besides the peculiar colour of prussian blue, and its amorphous appearance beneath the microscope, the residuum behaved as follows:—

1st. Insoluble in water.

2nd. Colour destroyed by sulphuric acid, and reproduced on the addition of water.

3rd. Both potash and soda bleached it, but the colour reappeared on the addition of either sulphuric or hydrochloric acid.

4th. Oxalic acid changed it to a most beautiful blue, but failed to dissolve it, probably owing to the organic matter with which it was, doubtless, still combined.

Twelve hours after a large quantity of paler urine was passed, in which not a trace of either salt injected was discovered.

Forty-eight hours after the dog had been first injected it was killed.

There were about two ounces of bloody serum in the abdomen.

Not a trace of iron or potash were found in this serum or in any of the tissues.

No prussian blue in the thoracic duct or elsewhere.

Experiment 4.—Injected one and a-half ounce of warm saturated solution of ferrocyanide of potassium beneath the skin of the back of a large dog. Some hours after urine was voided, containing abundance of the salt injected. This upon evaporation yielded yellow crystals. No trace of blue.

Experiment 5.—Saturated some human urine with ferrocyanide of potassium. On evaporation crystals, as in the last experiment. No blue colour.

It thus appears that when iron is introduced into the system, it passes off by the kidneys in combination with some other constituent, from which it is only separated by heat, when, if the ferrocyanide of potassium is present, prussian blue is immediately formed. It does not appear that the ferrocyanide of potassium is in any other state than solution. Neither of the salts were ever detected in the fæces; the same is true of the aniline dyes.

It is known that ferrocyanide of potassium, by exposure, assumes a blue tint, yet is still crystalline. Experiments 4 and 5 were instituted to see if, by the process of evaporation, a similar colour could be produced, so as to cause a doubtful result. They prove clearly the presence in Experiments 1, 2, and 3, of a far larger amount of iron than is contained in any ferrocyanide, sufficient indeed to produce the well-known amorphous prussian blue of commerce.

Whilst these experiments show no such combination takes place within the body, still they reveal the presence of a salt in the blood, chyle, and urine, which upon evaporation at ordinary temperatures appears as minute bright blue crystals.

ART. VI.—*On Differential Equations and on Co-resolvents.* By the HONOURABLE CHIEF JUSTICE COCKLE, F.R.S., President of the Queensland Philosophical Society, &c. Communicated by the HONOURABLE SIR REDMOND BARRY, Chancellor of the University of Melbourne, &c.

[Read 11th June, 1866.]

§ 1. *On Differential Equations.*

1. I propose to show that any linear differential equation whatever can be deprived of its second and third terms simultaneously, provided that we are at liberty to assume the solution of the general linear differential of the second order; or, in other words, that the annihilation of the second and third terms of any linear differential equation may be made to depend upon the solution of a linear differential equation of the second order. This is the analogue of the proposition that the second and third terms of an algebraical equation may be made to vanish simultaneously by means of the solution of a quadratic only.

2. Since any linear differential equation can be deprived of its second term by solving a linear differential equation of the first order only, we are at liberty to start from the equation of the third order—

$$\frac{d^3y}{dx^3} + 3r\frac{dy}{dx} + sy = 0 \quad - \quad - \quad (a)$$

3. Now, inasmuch as the complexity of the formulæ renders it necessary, or at all events desirable, to abridge the notation as much as possible, I shall have recourse to the following abbreviations. I shall denote differentiations with respect to the variable x by acute accents ($'$), and differentiations with respect to a new independent variable t by grave accents ($`$). Thus I shall write—

$$\frac{dy}{dx} = y', \frac{d^2y}{dx^2} = y'', \frac{d^3y}{dx^3} = y''', \text{ \&c.}$$

$$\frac{dy}{dt} = y`, \frac{d^2y}{dt^2} = y``, \frac{d^2y}{dt^2} = y```, \text{ \&c.}$$

The letters r and s in equation (a) denote any constants or any functions of x, the multiplier '3' being prefixed to r

for convenience only. In the abridged notation (*a*) will be written

$$y''' + 3\,r\,y' + s\,y = 0 \quad - \quad - \quad - \quad (b)$$

4. Change the dependent variable from y to Y where y and Y are connected by the relation

$$y = u\,Y \quad - \quad - \quad - \quad - \quad (c)$$

proceeding as follows :—

$$\begin{aligned} y''' = \quad (u\,Y)''' &= u\,Y''' + 3\,u'\,Y'' + 3\,u''\,Y' + u'''\,Y, \\ 3\,r\,y' = 3\,r\,(u\,Y)' &= \qquad\qquad 3\,r\,u\,Y' + 3\,r\,u'\,Y \\ s\,y = \quad s\,(u\,Y) &= \qquad\qquad\qquad\quad s\,u\,Y \end{aligned}$$

whence, bearing in mind the relation (*b*),

$$u\,Y''' + 3\,u'\,Y'' + 3\,(u'' + r\,u)\,Y' + (u''' + 3\,r\,u' + s\,u)\,Y = 0 \quad - \quad (d)$$

or, dividing by u,

$$Y''' + 3\frac{u'}{u}\,Y'' + 3\left(\frac{u''}{u} + r\right)Y' + \left(\frac{u'''}{u} + 3\,r\,\frac{u'}{u} + s\right)Y = 0 \quad - \quad (e)$$

5. Next change the independent variable from x to t and we find, after dividing by $\left(\frac{d\,t}{d\,x}\right)^2$ or $(t')^2$, that (*e*) becomes, if we confine, for a moment, the change to Y', Y'', and Y'''

$$\left.\begin{aligned} Y''' + 3\left(\frac{u'}{u}\cdot x' - \frac{x''}{x'}\right)Y'' + \Big\{ 3\left(\frac{u''}{u} + r\right)(x')^2 - 3\frac{u'}{u}\,x''\Big\} \\ + 3\left(\frac{x''}{x'}\right)^2 - \frac{x'''}{x'}\Big\}\,Y' + F\,(u, x, t).\ Y = 0 \end{aligned}\right\} \quad (f)$$

where $F\,(u, x, t)$ is a function which it is not at present necessary to develope.

6. Hence, one of the conditions of the proposed transformation being that the second term of (*f*) should disappear, or, what amounts to the same thing, that the co-efficient of Y'' should vanish, we have, first,

$$\frac{u'}{u}\cdot x' - \frac{x''}{x'} = 0 \quad - \quad - \quad - \quad - \quad (g)$$

which reduces to

$$\frac{u'}{u} - \frac{x''}{x'} = 0 \quad - \quad - \quad - \quad - \quad - \quad (h)$$

of which equation a first integral is

$$u = C\,x' \quad - \quad - \quad - \quad - \quad - \quad (i)$$

whence follow

$$u' = C\,x'', \; u'' = C\,x''', \text{ \&c.} \quad - \quad - \quad (j, k \ldots)$$

7. Our next object is to eliminate u from the co-efficient of Y', and for this purpose we deduce at once from (g) the relation

$$\frac{u'}{u} = \frac{x''}{(x')^2} \quad - \quad - \quad - \quad - \quad - \quad - \quad (l)$$

moreover

$$\frac{u''}{u} = \left\{ \frac{u''}{(x')^2} - \frac{x''}{(x')^3} \cdot u' \right\} \frac{1}{u} \quad - \quad - \quad (m)$$

$$= \frac{x'''}{(x')^3} - \frac{(x'')^2}{(x')^4} \quad - \quad - \quad - \quad - \quad - \quad (n)$$

as we see from inspecting (i) and $(j, k, \ldots)$. Hence the co-officient of Y' in (f) becomes, on substitution,

$$3\left\{ \frac{x'''}{(x')^3} - \frac{(x'')^2}{(x')^4} + r \right\} (x')^2 - 3\,\frac{(x'')^2}{(x')^2} + 3\left(\frac{x''}{x'}\right)^2 - \frac{x'''}{x'}$$

and reducing this expression and equating the result to zero we find, as the second condition of the proposed transformation,

$$2\,\frac{x'''}{x'} - 3\left(\frac{x''}{x'}\right)^2 + 3\,r\,(x')^2 = 0 \quad - \quad - \quad (o)$$

an equation connecting x and t directly.

8. It remains to be proved that (o) is reducible to a linear differential equation of the second order. To this end, let

$$x' = p \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad (p)$$

and consequently

$$x'' = p' = p' \cdot p \quad - \quad - \quad - \quad - \quad - \quad (q)$$

and also

$$x''' = p'' = p'' \cdot p^2 + (p')^2 \cdot p \quad - \quad - \quad - \quad (r)$$

then (o) becomes, after substitutions,

$$2\,p\,p'' + 2\,(p')^2 - 3\,(p')^2 + 3\,r\,p^2 = 0,$$

and, on reduction,

$$2\,p\,p'' - (p')^2 + 3\,r\,p^2 = 0 \quad - \quad - \quad - \quad (s)$$

Now divide this result by p^2 and we have

$$2\,\frac{p''}{p} - \left(\frac{p'}{p}\right)^2 + 3\,r = 0 \quad - \quad - \quad - \quad (t)$$

or

$$2\,\frac{d}{dx}\left(\frac{p'}{p}\right) + \left(\frac{p'}{p}\right)^2 + 3\,r = 0 \quad - \quad - \quad (u)$$

and if we make

$$\frac{p'}{p} = 2\,v \quad - \quad - \quad - \quad - \quad - \quad (v)$$

then (u) becomes, on dividing by 4

$$\frac{d\,v}{d\,x} + v^2 + \frac{3}{4}\,r = 0 \quad - \quad - \quad - \quad (w)$$

whence also

$$e^{\int v\,dx}\left(\frac{d\,v}{d\,x} + v^2 + \frac{3}{4}\,r\right) = 0 \quad - \quad - \quad (x)$$

or, making $e^{\int v\,dx} = w$, - - - - - - (y)

$$\frac{d^2\,w}{d\,x^2} + \frac{3}{4}\,r\,w = 0 \quad - \quad - \quad - \quad (z)$$

a linear differential equation of the second order.

9. From (y) we deduce

$$v = \frac{1}{w} \cdot \frac{d\,w}{d\,x} \quad - \quad - \quad - \quad (aa)$$

and, combining this with (v) we find, on integration, &c.,

$$p = C_2\,w^2 \quad - \quad - \quad - \quad - \quad (ab)$$

whence, by (p),

$$\frac{d\,t}{d\,x} = \frac{1}{p} = \frac{1}{C_2\,w^2} \quad - \quad - \quad - \quad (ac)$$

or

$$t = \frac{1}{C_2}\int \frac{d\,x}{w^2} + C_3 \quad - \quad - \quad - \quad (ad)$$

We find also, combining (i) and (p) and (ab) that

$$u = C\,C_2\,w^2 \quad - \quad - \quad - \quad - \quad (ae)$$

which two constants are of course equivalent to one only.

10. The transformation thus indicated for the third order is possible for equations of any order. For starting with the equation, deprived of its second term and in which n is greater than 3,

$$\frac{d^n y}{d x^n} + r \frac{d^{n-2} y}{d x^{n-2}} + \&c. = 0 \quad - \quad - \quad (\alpha)$$

we obtain by means of Mr. S. S. Greatheed's general formulæ for the change of the independent variable (in the *Cambridge Mathematical Journal*, vol. i. pp. 236—8) the following results, true for all values of n:

$$\frac{d^n y}{d x^n} = q_1 \frac{d y}{d t} + q_2 \frac{d^2 y}{d t^2} + \ldots q_n \frac{d^n y}{d t^n}, \quad - \quad (\beta)$$

where

$$q_p = M \left\{ \left(\frac{d^\lambda t}{d x^\lambda}\right)^\alpha \left(\frac{d^\mu y}{d x^\mu}\right)^\beta \left(\frac{d^\nu y}{d x^\nu}\right)^\gamma \right\} \quad - \quad (\gamma)$$

M meaning a multiple of the included quantities, and α, β, γ, &c, and λ, μ, ν, &c., being subject to the two relations

$$\alpha + \beta + \gamma + \ldots = p \quad - \quad - \quad - \quad (\delta)$$

$$\alpha\lambda + \beta\mu + \gamma\nu + \ldots = n \quad - \quad - \quad - \quad (\epsilon)$$

11. We are only concerned with the first three terms of the transformed equation. For the first put $p = n$ and subtract (δ) from (ϵ). The result is

$$\alpha(\lambda - 1) + \beta(\mu - 1) + \gamma(\nu - 1) + \ldots = 0 \quad - \quad (\zeta)$$

of which, since α, &c., and λ, &c., are to be integers, the only available solutions are

$$\lambda = 1,\ \mu = 1,\ \nu = 1, \ldots \alpha = 1,\ \beta = 1,\ \gamma = 1, \ldots$$

consequently

$$q_n = M \left\{ \left(\frac{d t}{d x}\right)^n \right\} \quad - \quad - \quad - \quad (\eta)$$

Next, let $p = n - 1$, then subtracting as before

$$\alpha(\lambda - 1) + \beta(\mu - 1) + \gamma(\nu - 1) + \ldots = 1 \quad - \quad (\theta)$$

the only available solutions of which are of the form

$$\lambda = 2,\ \mu = 1,\ \nu = 1, \ldots \alpha = 1,\ \beta = 1,\ \gamma = 1, \ldots$$

so that

$$q_{n-1} = M \left\{ \frac{d^2 t}{d x^2} \left(\frac{d t}{d x}\right)^{n-1} \right\} \quad - \quad - \quad (\iota)$$

Again, when $p=n-2$, we have, subtracting as before, the condition

$$\alpha(\lambda-1)+\beta(\mu-1)+\gamma(\nu-1)+\ldots=2 \qquad (\kappa)$$

of which the only available solutions are of the forms

$$\lambda=3,\ \mu=1,\ \nu=1,\ \rho=1,\ \ldots\ \alpha=1,\ \beta=1,\ \ldots$$

and

$$\lambda=2,\ \mu=2,\ \nu=1,\ \rho=1,\ \ldots\ \alpha=1,\ \beta=1,\ \ldots$$

Hence

$$q_{n-2}=M\left\{\frac{d^3t}{dx^3}\left(\frac{dt}{dx}\right)^{n-1}\right\}+M_2\left\{\left(\frac{d^2t}{dx^2}\right)^2\left(\frac{dt}{dx}\right)^{n-2}\right\} \qquad (\lambda)$$

and we see that the conditions for the annihilation of the second and third terms of an equation of any order will not essentially differ from those for equations of the third order already discussed.

The forms of the conditions also show that the simultaneous destruction of the second and rth terms of a linear differential equation of any order may be made to depend upon the solution of equations of the first and rth order: and thus far the analogy between algebra and the calculus holds—to a certain extent at least. I have not ascertained whether the resulting equation in the case of r being greater than 2 can be made linear.

12. The sinister of a linear (or simple) algebraical equation whose dexter is zero may be reduced to a single term by an easy transformation, and the sinister of a linear differential equation of the first order whose dexter is zero possesses the analogous property that, being multiplied into an appropriate factor, it may be reduced to the form of a perfect differential coefficient. We will now inquire whether the analogy between algebra and the differential calculus holds in the case of the next degree and order. And in so doing it will no longer be necessary for me to adhere to the abridged notation so conducive to the perspicuity of foregoing results and to the manageability of the formulæ involved in them. I proceed to attempt the annihilation of the last two terms of a linear differential equation of the second order, and for a reason given in Article 2 I shall start from the linear differential equation of the second order

$$\frac{d^2y}{dx^2}+ry=0 \qquad (1)$$

the transformation of which has no analogue in the theory of algebraical equations, inasmuch as a quadratic cannot be deprived of its second and last terms simultaneously. We shall thus see whether there is any instance in which the analogy fails to hold between algebra and the differential calculus.

13. To effect the proposed transformation of (1) I change the independent variable from x to t and, at the same time, the dependent variable from y to Y, the relation

$$y = u\,Y \quad - \quad - \quad - \quad - \quad (2)$$

subsisting between y and Y. The result of these changes is to transform (1) into

$$\frac{d^2(u\,Y)}{d\,t^2}\cdot\left(\frac{d\,t}{d\,x}\right)^2 - \frac{d(u\,Y)}{d\,t}\cdot\left(\frac{d\,t}{d\,x}\right)^3\cdot\frac{d^2x}{d\,t^2} + r\,(u\,Y) = 0 \quad (3)$$

or

$$\frac{d^2(u\,Y)}{d\,t^2} - \frac{d\,t}{d\,x}\cdot\frac{d^2x}{d\,t^2}\cdot\frac{d(u\,Y)}{d\,t} + r\left(\frac{d\,x}{d\,t}\right)^2(u\,Y)$$

14. Developing, we have

$$\frac{d^2(u\,Y)}{d\,t^2} = u\frac{d^2\,Y}{d\,t^2} + 2\,\frac{d\,u}{d\,t}\cdot\frac{d\,Y}{d\,t} + \frac{d^2u}{d\,t^2}\,Y$$

$$-\frac{d\,t}{d\,x}\cdot\frac{d^2x}{d\,t^2}\cdot\frac{d(uY)}{d\,t} = -u\frac{d\,t}{d\,x}\cdot\frac{d^2x}{d\,t^2}\cdot\frac{d\,Y}{d\,t} - \frac{d\,u}{d\,t}\cdot\frac{d\,t}{d\,x}\cdot\frac{d^2x}{d\,t^2}\,Y$$

$$r\left(\frac{d\,x}{d\,t}\right)^2(u\,Y) = r\,u\left(\frac{d\,x}{d\,t}\right)^2 Y.$$

Hence, (4) may, after division by u, be replaced by

$$\left.\begin{aligned}&\frac{d^2\,Y}{d\,t^2} + \left(\frac{2}{u}\cdot\frac{d\,u}{d\,t} - \frac{d\,t}{d\,x}\cdot\frac{d^2x}{d\,t^2}\right)\frac{d\,Y}{d\,t}\\ &+\left(\frac{1}{u}\cdot\frac{d^2u}{d\,t^2} - \frac{1}{u}\cdot\frac{d\,u}{d\,t}\cdot\frac{d\,t}{d\,x}\cdot\frac{d^2x}{d\,t^2} + r\left\{\frac{d\,x}{d\,t}\right\}^2\right)Y = 0\end{aligned}\right\} \quad (5)$$

15. Hence the conditions of the transformation are

$$\frac{2}{u}\cdot\frac{d\,u}{d\,t} - \frac{d\,t}{d\,x}\cdot\frac{d^2x}{d\,t^2} = 0 \quad - \quad - \quad - \quad (6)$$

and

$$\frac{1}{u}\cdot\frac{d^2u}{d\,t^2} - \frac{1}{u}\cdot\frac{d\,u}{d\,t}\cdot\frac{d\,t}{d\,x}\cdot\frac{d^2x}{d\,t^2} + r\left(\frac{d\,x}{d\,t}\right)^2 = 0 \quad - \quad (7)$$

which equations I proceed to solve.

16. From (6), that is to say from

$$\frac{2}{u} \cdot \frac{du}{dt} = \frac{\frac{d^2x}{dt^2}}{\frac{dx}{dt}}, \quad - \quad - \qquad (8)$$

we deduce by integration

$$\log.\,(u^2) = \log.\left\{ C \left(\frac{dx}{dt} \right) \right\}$$

or

$$u^2 = C \cdot \frac{dx}{dt} \quad - \quad - \quad - \quad - \quad (9)$$

and by differentiation

$$\frac{2}{u} \cdot \frac{d^2u}{dt^2} - \frac{2}{u^2} \cdot \left(\frac{du}{dt} \right)^2 = \frac{\frac{d^3x}{dt^3}}{\frac{dx}{dt}} - \left\{ \frac{\frac{d^2x}{dt^2}}{\frac{dx}{dt}} \right\}^2 \qquad (10)$$

and (8) enables us to write (7) in the form

$$\frac{1}{u} \cdot \frac{d^2u}{dt^2} - 2\left(\frac{1}{u} \cdot \frac{du}{dt} \right)^2 + r\left(\frac{dx}{dt} \right)^2 = 0 \quad - (11)$$

from which if we eliminate u by means of (8) and (10) we obtain

$$\frac{1}{2} \cdot \frac{\frac{d^3x}{dt^3}}{\frac{dx}{dt}} - \frac{3}{4} \cdot \left(\frac{\frac{d^2x}{dt^2}}{\frac{dx}{dt}} \right)^2 + r\left(\frac{dx}{dt} \right)^2 = 0 \quad - (12)$$

17. Now assume

$$\frac{dx}{dt} = p \quad - \quad - \quad - \quad - (13)$$

whence

$$\frac{d^2x}{dt^2} = \frac{dp}{dt} = \frac{dp}{dx} \cdot p, \text{ and } \frac{d^3x}{dt^3} = \frac{d^2p}{dx^2} \cdot p^2 + \left(\frac{dp}{dx} \right)^2 p \qquad (14,15)$$

and eliminate t from (12). That equation becomes

$$\frac{1}{2} \cdot p\frac{d^2p}{dx^2} + \frac{1}{2}\left(\frac{dp}{dx} \right)^2 - \frac{3}{4}\left(\frac{dp}{dx} \right)^2 + rp^2 = 0 \quad - (16)$$

or, multiplying (16) into 4 and reducing

$$2p\frac{d^2p}{dx^2} - \left(\frac{dp}{dx}\right)^2 + 4rp^2 = 0 \quad - \quad - (17)$$

18. This equation is of the second order. It remains to be shown that its solution depends upon that of a linear equation of the same order. To this end divide it by p^2 and it becomes

$$\frac{2}{p}\cdot\frac{d^2p}{dx^2} - \frac{1}{p^2}\left(\frac{dp}{dx}\right)^2 + 4r = 0 \quad - \quad - (18)$$

which is equivalent to

$$2\frac{d}{dx}\left\{\frac{1}{p}\cdot\frac{dp}{dx}\right\} + \left(\frac{1}{p}\cdot\frac{dp}{dx}\right)^2 + 4r = 0 \quad - (19)$$

19. Now if we put

$$\frac{1}{p}\cdot\frac{dp}{dx} = av \quad - \quad - \quad - \quad - (20)$$

then (19) becomes

$$2a\frac{dv}{dx} + a^2v^2 + 4r = 0 \quad - \quad - \quad - (21)$$

which if $a = 2$ reduces to

$$\frac{dv}{dx} + v^2 + r = 0 \quad - \quad - \quad - (22)$$

and so to

$$e^{\int v\,dx}\left(\frac{dv}{dx} + v^2 + r\right) = 0$$

or (making

$$e^{\int v\,dx} = w)$$

to

$$\frac{d^2w}{dx^2} + rw = 0 \quad - \quad - \quad - \quad - (23)$$

20. Now, retracing our steps, we see that (1) and (23) are identical in form, and also that (compare article 9)

$$p = \frac{dx}{dt} = C_2w^2 \quad - \quad - \quad - \quad - (24)$$

whence, by equation (9),

$$u^2 = C\frac{dx}{dt} = C\,C_2\,w^2 \quad - \quad - \quad - \quad - (25)$$

$$\text{and } \therefore\ u = M\,w \quad - \quad - \quad - \quad - \quad - \quad - (26)$$

M being a constant. The analogy between the algebraical and differential theories holds then thus far: the supposition that u or, which is the same thing, w is known, is the same as supposing that the solution of (1) the given equation, is known, and consequently to effect the transformation we have to encounter all the difficulties of solving the original equation. The analogy fails thus far: if we can solve (1) we can annihilate its final term. This failure of analogy seems analogous to another failure of analogy between quadratics and linear differential equations of the second order: a quadratic may have equal roots, but there are two arbitrary constants in the complete integral of every linear differential equation of the second order.

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§ 2. *On Co-resolvents.*

21. The Theory of Co-resolvents originated in my "Sketch of a Theory of Transcendental Roots," published in the *Philosophical Magazine* for August, 1860. The subject of that paper has since been pursued as well by myself as by Mr. Harley, Professor Cayley, Mr. Russell, Mr. Rawson, Mr. Spottiswoode, and the lamented Boole. When two or more conditions involving a quantity are simultaneously satisfied by the same value of the quantity, those conditions, and indeed that by which the value is determined, may be termed "Co-resolvents," and one co-resolvent may sometimes not inaptly be termed a "resolvent" of another. The co-resolvents may be 'algebraical resolvents,' or 'differential resolvents,' or 'functional resolvents.' Thus the three equations

$$y^3 - 3\,y + 2\,x = 0 \quad - \quad - \quad - \quad (i)$$

$$3^2\,(1 - x^2)\,\frac{d^2y}{dx^2} - 3^2\,x\,\frac{dy}{dx} + y = 0 \quad - \quad (ii)$$

$$\frac{d\,\phi(x)}{dx} + \frac{\phi\,(\sqrt{1-x^2})}{3\sqrt{1-x^2}} = 0, \quad - \quad - \quad (iii)$$

in the first two of which y is to be taken to represent $\phi\ (x)$, are co-resolvents. The first is the algebraical resolvent, the second is the differential resolvent, and the third is a functional resolvent. If the variable x be not greater than positive unity, or less than negative unity, the relation

$$\phi\ (x) = 2 \sin. \left(\frac{2\pi + \sin.^{-1} x}{3}\right) \quad - \quad - \text{ (iv)}$$

is a solution, and the only common solution, of the above system of co-resolvents, while, on the other hand, all the roots of (i) are solutions of (ii). The theory of co-resolvents not only throws light on those of algebraical and of differential equations, but it enables us to make the solution of whole classes of functional equations depend upon that of algebraical or of differential equations. The well-known application of the theory of algebraical equations to the solution of linear differential equations with constant coefficients, the analogies between the theories of algebraical and differential equations pointed out by Libri and Lioüville and the communication between the two theories established by Abel, when he explored the track upon which Euler had entered, may give interest to the new communication between those theories opened by the method of co-resolvents.

22. Before proceeding to that development of the theory which it is the object of this section to explain, I ought to say that its present advanced state is, in no small measure, attributable to Mr. Harley. That eminent mathematician, by his earlier inquiries into the forms of the differential resolvents of certain trinomial algebraical equations, obtained results which not only excited attention at the time, but which have also, to a great extent, determined the current of subsequent research. Traces of Mr. Harley's investigations appear in almost every paper that has since been published. His approach to the following theorem was simultaneous with my own.

23. If u represent the mth power of any root of the algebraical equation

$$y^n - x\,y^r - 1 = 0 \quad - \quad - \quad - \text{ (v)}$$

then u, considered as a function of x, satisfies the linear differential equation

$$[D]^n u - \left[\frac{m + rD}{n} - 1\right]^r \left[\frac{m - (n-r)D}{n} + n - r\right]^{n-r} x^n u = 0 \quad \text{(vi)}$$

in which D is an operative symbol defined by

$$D = x\frac{d}{dx} \quad - \quad - \quad - \quad - \text{(vii)}$$

and the notation

$$[a]^b = a\,(a-1)\,(a-2)\,..\,(a-b+1) - \qquad \text{(viii)}$$

is adopted. This theorem is an extension of Boole's proposition at pages 734 and 735 of the *Philosophical Transactions* for 1864. If we make

$$r = n-1\,,\ x = e^{\theta}$$

and therefore regard D as representing the operation $\frac{d}{d\theta}$, then (vi) will become

$$[D]^n u + \left[\frac{n-1}{n}D + \frac{m}{n} - 1\right]^{n-1}\left(\frac{D}{n} - \frac{m}{n} - 1\right)e^{n\theta}u = 0 \quad \text{(ix)}$$

and so coincide with the equation given by Boole at the pages cited.

24. As a second verification of this theorem let $r = 1$, then (vi) becomes

$$[D]^n u - \frac{1}{n}(D - n + m)\left[\frac{m}{n} - \frac{n-1}{n}D + n - 1\right]^{n-1} x^n u = 0 \quad \text{(x)}$$

which, when $m = 1$, becomes

$$[D]^n y - \frac{1}{n}(D - n + 1)\left[\frac{1}{n} - \frac{n-1}{n}D + n - 1\right]^{n-1} x^n y = 0 \quad \text{(xi)}$$

or, which is the same thing,

$$[D]^n y + \frac{1}{n}\left[\frac{n-1}{n}D - \frac{1}{n} - 1\right]^{n-1}(D - n + 1)(-x)^n y = 0 \quad \text{(xii)}$$

which is the n-ary differential resolvent of

$$y^n - x\,y - 1 = 0 \quad - \quad - \quad - \qquad \text{(xiii)}$$

Now if in (xii) we replace x by $-x$, and afterwards, as before, substitute e^{θ} for x, then (xii) becomes

$$[D]^n y + \frac{1}{n}\left[\frac{n-1}{n}D - \frac{1}{n} - 1\right]^{n-1}(D - n + 1)e^{n\theta}y = 0 \quad \text{(xiv)}$$

which is the n-ary differential resolvent of

$$y^n + x\,y - 1 = 0 \quad - \quad - \qquad \text{(xv)}$$

This result coincides ultimately with Boole's. For if in (xv) we replace y by y^{-1} we have an equation employed by Boole (*ibid.* p. 736) and if in (xiv) we replace y by u we have its n-ary resolvent as given by him (*ibid.* p. 737).

25. If we make

$$G = \frac{r}{n} D + \frac{m}{n} - 1 \quad - \quad - \quad - \quad \text{(xvi)}$$

and

$$H = \frac{m - (n - r) D}{n} + n - r \quad - \quad \text{(xvii)}$$

the general theorem may conveniently be expressed as follows :—The n-ary, or Boolian differential resolvent of (v) is

$$[D]^n u - [G]^r [H]^{n-r} x^n u = 0 \quad - \quad \text{(xviii)}$$

26. I communicated the generalization of Boole's proposition to Mr. Harley by the last October mail, together with a verification—both verifications, I believe. By the last December mail I received a letter from Mr. Harley, dated Oct. 17, 1865, which therefore crossed my letter to him, and in which he makes a very near approach indeed to the true generalization : so near, indeed, that, inasmuch as the oversight into which he has fallen could not long have escaped his notice, the generalization may be regarded as having been independently made by me in Queensland, Australia, and by him in England. By the last (February) mail I received from Mr. Harley a letter dated Dec. 18, 1865, in which he acknowledges my letter of the 18th Oct. and in substance says that the true generalization is

$$[D]^n u - (-)^{n-r} [G]^r [H]^{n-r} x^{n-r} u = 0 \quad - \quad \text{(xix)}$$

where

$$H = \frac{n - r}{n} D - \frac{m}{n} - 1 \quad - \quad - \quad \text{(xx)}$$

Now, inasmuch as

$$\left[\frac{m - (n-r) D}{n} + n - r\right]^{n-r} = \left[\frac{n-r}{n} D - \frac{m}{n} - 1\right]^{n-r} (-1)^{n-r} \quad \text{(xxi)}$$

the only real discrepancy between our results consists in the different indices of x. Mr. Harley's factor 'x^{n-r}' seems to me erroneous, and neither to follow from the law of derivation of a differential equation from a series, nor to agree

either with Boole's results or with obvious properties of the n-ary resolvent of the equation in y or y^m. If the general n-ary resolvent of (v) be denoted by

$$f(m, x) = 0 \quad - \quad - \quad - \quad - \quad \text{(xxii)}$$

that of

$$\left(\frac{1}{y}\right)^n + x\left(\frac{1}{y}\right)^{n-r} - 1 = 0 \quad - \quad \text{(xxiii)}$$

or, what is the same thing, of

$$(y^{-1})^n + x\,(y^{-1})^{n-r} - 1 = 0 \quad - \quad - \quad \text{(xxiv)}$$

will still be (xxii), for (xxiii) is but the result of the division of (v) by y^n. Hence if in (xxiv) we replace y^{-1} by z and x by $-x$, we must replace m by $-m$ and x by $-x$ in (xxii) in order to obtain the n-ary resolvent of

$$z^n - x\,z^{n-r} - 1 = 0 \quad - \quad - \quad - \quad \text{(xxv)}$$

that resolvent is, consequently,

$$f(-m, -x) = 0 \quad - \quad - \quad - \quad \text{(xxvi)}$$

in other words when, in (v) we change r into $n - r$ the index of x in the resolvent remains unaltered.

27. The demonstration of the generalized theorem is as follows. Let

$$y^n - x\,y^a - 1 = 0 \quad - \quad - \quad \text{(xxvii)}$$

then by Lagrange's theorem, employed precisely as Boole has done (*ibid.* p. 735), we find that u or y^m may be expanded in a series of the form

$$u_0 + u_1 x + u_2 x^2 + \&c.\ ad.\ inf.,$$

in which

$$u_r = \frac{m\left[\frac{m + a\,r}{n} - 1\right]^{r-1} \times (1)^{\frac{m-r}{n}}}{n\,[r]^r} \quad - \quad \text{(xxviii)}$$

and consequently

$$[r]^n u_r = \frac{m\left[\frac{m + a\,r}{n} - 1\right]^{r-1} \cdot (1)^{\frac{m-r}{n}}}{n\,[r-n]^{r-n}} \quad - \quad \text{(xxix)}$$

28. Changing r into $r-n$ we have, from (xxviii),

$$u_{r-n} = \frac{m\left[\frac{m+ar}{n} - a - 1\right]^{r-n-1} \cdot (1)^{\frac{m-r}{n}}}{n\,[r-n]^{r-n}} \qquad \text{(xxx)}$$

Hence, dividing (xxix) by (xxx),

$$\frac{[r]^n u_r}{u_{r-n}} = \frac{\left[\frac{m+ar}{n} - 1\right]^{r-1}}{\left[\frac{m+ar}{n} - a - 1\right]^{r-n-1}} \qquad \text{(xxxi)}$$

But

$$\left[\frac{m+ar}{n} - a - 1\right]^{r-n-1} = \frac{\left[\frac{m+ar}{n} - 1\right]^{r-n-1+a}}{\left[\frac{m+ar}{n} - 1\right]^{a}}$$

$$= \frac{\left[\frac{m+ar}{n} - 1\right]^{r-1}}{\left[\frac{m+ar}{n} - 1\right]^{a}\left[\frac{m+ar}{n} - r + n - a\right]^{n-a}} \qquad \text{(xxxi)}$$

consequently

$$\frac{[r]^n u_r}{u_{r-n}} = \left[\frac{m+ar}{n} - 1\right]^{a}\left[\frac{m+ar}{n} - r + n - a\right]^{n-a}$$

or, making two obvious changes in the form of this result

$$[r]^n u_r - \left[\frac{m+ar}{n} - 1\right]^{a}\left[\frac{m-(n-a)r}{n} + n - a\right]^{n-a} u_{r-n} = 0 \qquad \text{(xxxii)}$$

This equation corresponds to Boole's equation (6) (*ibid.* p. 736) which requires correction in two places and should stand thus:

$$[r]^n u_r + \left[\frac{m+(n-1)r}{n} - 1\right]^{n-1}\left(\frac{r}{n} - \frac{m}{n} - 1\right) u_{r-n} = 0 \quad (6)$$

29. Multiply both sides of (xxxii) into x^r and it becomes

$$[r]^n u_r \,.\, x^r - \left[\frac{m+ar}{n} - 1\right]^{a}\left[\frac{m-(n-a)r}{n} + n - a\right]^{n-a} .\, x^n \,.\, u_{r-n} \,.\, x^{r-n} = 0 \qquad \text{(xxxiii)}$$

or (since

$$x\frac{d}{dx}(x^k) = k\Big)$$

$$[D]^n u_r . x^r - \left[\frac{m+aD}{n} - 1\right]^a \left[\frac{m-(n-a)D}{n} + n - a\right]^{n-a} x^n . u_{r-n} . x^{r-n} = 0$$

(xxxiv)

Next, in (xxxiv), give to r all successive values from zero to infinity and add the results: we find, since

$$u_0 + u_1 x + u_2 x^2 + \&c.\ ad.\ inf. = u,$$

$$[D]^n u - \left[\frac{m+aD}{n} - 1\right]^a \left[\frac{m-(n-a)D}{n} + n - a\right]^{n-a} x^n u = 0 \quad \text{(xxxv)}$$

Hence if in (xxvii) we replace a by r and, consequently, make the same change in (xxxv) that last equation becomes

$$[D]^n u - \left[\frac{m+rD}{n} - 1\right]^r \left[\frac{m-(n-r)D}{n} + n - r\right]^{n-r} x^n u = 0 \quad \text{- (vi)}$$

and thus the theorem announced at the commencement of Article 23 is established. The constant r which replaces the constant a will not of course be confounded with the variable integer r used in the investigations immediately preceding.

Brisbane, Queensland, Australia,
March 16, 1866.

Abstract of the Addendum to Chief Justice Cockle's *Paper "On Differential Equations," &c., communicated to* Sir Redmomd Barry.

In an Addendum to the above paper, dated April 9th-10th, 1866, Chief Justice Cockle gives a co-resolvent of a third form of trinomial algebraic equation undiscussed by Mr. Harley and the lamented Boole. After obtaining this last co-resolvent by means of Laplace's theorem, the Chief Justice gives a general theorem for the development of functions of two independent quantities. Lagrange's theorem and Laplace's theorem are particular cases of this general theorem.

Addendum to the foregoing Paper.

Under date Oakwal, near Brisbane, April 9, 1866, Chief Justice Cockle communicated to Sir Redmond Barry the following additions to his Paper "On Differential Equations and on Co-resolvents."

I. We may readily deduce a differential co-resolvent of

$$x\,y^n - y^a + z = 0\,, \qquad \text{(a)}$$

from which we obtain successively

$$y^a = z + x\,y^n \qquad \text{(b)}$$

$$y = (z + x\,y^n)^{\frac{1}{a}} \qquad \text{(c)}$$

$$y^m = (z + x\,y^n)^{\frac{m}{a}} \qquad \text{(d)}$$

Hence, by Laplace's theorem,

$$y^m = z^{\frac{m}{a}} + \left\{ z^{\frac{n}{a}} \left(\frac{m}{a} z^{\frac{m}{a}-1} \right) \right\} \frac{x}{1} + \frac{d}{dz} \left\{ z^{\frac{2n}{a}} \left(\frac{m}{a} z^{\frac{m}{a}-1} \right) \right\} \frac{x^2}{1.2} + \&c. \qquad \text{(e)}$$

II. Now since the general term of the series for y^m is

$$\frac{m}{a} \cdot \frac{d^{r-1}}{d\,z^{r-1}} \left\{ z^{\frac{rn}{a}} \cdot z^{\frac{m}{a}-1} \right\} \frac{x^r}{1.2..r}$$

or

$$\frac{m}{a} \cdot \frac{d^{r-1}}{d\,z^{r-1}} \left\{ z^{\frac{rn}{a}+\frac{m}{a}-1} \right\} \frac{x^r}{[r]^r}$$

or, if we make $z = 1$ after the differentiations,

$$\frac{m}{a} \left[\frac{r\,n}{a} + \frac{m}{a} - 1 \right]^{r-1} \frac{x^r}{[r]^r}$$

we may put

$$[r]^r u_r = \frac{m}{a} \left[\frac{r\,n}{a} + \frac{m}{a} - 1 \right]^{r-1} \qquad \text{(f)}$$

and, consequently,

$$[r-a]\,u_{r-a} = \frac{m}{a} \left[\frac{(r-a)\,n}{a} + \frac{m}{a} - 1 \right]^{r-a-1} \qquad \text{(g)}$$

III. It follows that

$$[r]^a u_r = \frac{\left[\frac{rn}{a} + \frac{m}{a} - 1\right]^{r-1}}{\left[\frac{rn}{a} + \frac{m}{a} - 1 - n\right]^{r-a-1}} u_{r-a} \quad \text{- - (h)}$$

But

$$\left[\frac{rn}{a} + \frac{m}{a} - (1+n)\right]^{r-a-1} = \frac{\left[\frac{rn}{a} + \frac{m}{a} - 1\right]^{r-a-1+n}}{\left[\frac{rn}{a} + \frac{m}{a} - 1\right]^{n}}$$

$$= \frac{\left[\frac{rn}{a} + \frac{m}{a} - 1\right]^{r-1} \left[\frac{rn}{a} + \frac{m}{a} - r\right]^{n-a}}{\left[\frac{rn}{a} + \frac{m}{a} - 1\right]^{n}} \quad \text{- (i)}$$

and (h) becomes

$$[r]^a u_r = \frac{\left[\frac{rn}{a} + \frac{m}{a} - 1\right]^{n}}{\left[\frac{rn}{a} + \frac{m}{a} - r\right]^{n-a}} \cdot u_{r-a} \quad \text{- - (j)}$$

IV. Proceeding as in the former part of this paper we, slightly changing the form of (j), infer that, since

$$[r]^a \left[\frac{(n-a)r}{a} + \frac{m}{a}\right]^{n-a} u_r - \left[\frac{rn}{a} + \frac{m}{a} - 1\right]^{n} u_{r-a} = 0 \quad \text{(k)}$$

consequently that, as in a former case, the co-resolvent will be

$$[D]^a \left[\frac{(n-a)D}{a} + \frac{m}{a}\right]^{n-a} u - \left[\frac{nD}{a} + \frac{m}{a} - 1\right]^{n} x^a u = 0 \quad \text{(l)}$$

in which last equation u represents y^m. This (l) is the co-resolvent of (a) for the case of $z = 1$. We may obtain it for any value of z by multiplying the last term of (l) into z^{n-a}, for the exponent of z will be

$$\frac{rn}{a} + \frac{m}{a} - r - \left(\frac{(r-a)n}{a} + \frac{m}{a} - r + a\right) = n - a$$

We shall thus give to the co-resolvent an extension equivalent to that which Mr. Harley has sought to give to another

result. I find that Mr. Harley's extension of the theorem spoken of in the former part of this memoir is printed at p. 199 of Boole's (posthumous) Supplementary Volume, which reached me by the last (March) mail. The extension as there printed is erroneous to an extent which I have already pointed out.

V. In general, let

$$u = f(y) \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad \text{(m)}$$

$$y = \psi(w) \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad \text{(n)}$$

$$w = (a z + b x) F(y) + (a x + b z) \pi(y) + \chi(y) \quad \text{(o)}$$

in which x and z are independent, and F, π, and χ are functional symbols, and let it be required to expand u in a series of ascending powers of x.

VI. Put

$$(a z + b x) \frac{d F(y)}{d y} + (a x + b z) \frac{d \pi(y)}{d (y)} + \frac{d \chi(y)}{d (y)} = H \quad \text{(p)}$$

and we have

$$\frac{d y}{d x} = \frac{d \psi(w)}{d w} \cdot \frac{d w}{d x} = \frac{d \psi(w)}{d w} \cdot \left(H \frac{d y}{d x} + b F(y) + a \pi(y) \right) \quad \text{(q)}$$

In like manner

$$\frac{d y}{d z} = \frac{d \chi(w)}{d w} \left(H \frac{d y}{d z} + a F(y) + b \pi(y) \right) \quad - \quad - \quad \text{(r)}$$

and therefore, putting (q) and (r) under the forms

$$\frac{d y}{d x} \left(1 - H \frac{d \psi(w)}{d w} \right) = \frac{d \psi(w)}{d w} \left(b F(y) a \pi(y) \right) \quad \text{(s)}$$

$$\frac{d y}{d z} \left(1 - H \frac{d \psi(w)}{d w} \right) = \frac{d \psi(w)}{d w} \left(a F(y) + b \pi(y) \right) \quad \text{(t)}$$

and dividing (s) by (t) we have, after a slight reduction,

$$\frac{d y}{d x} = \left\{ \begin{matrix} b F(y) + a \pi(y) \\ a F(y) + b \pi(y) \end{matrix} \right\} \frac{d y}{d z} \quad - \quad - \quad - \quad - \quad \text{(u)}$$

VII. For simplicity, divide both the numerator and denominator of the bracketed factor of the dexter of (u) by $F(y)$, then (u) becomes

$$\frac{d y}{d x} = \left\{ \frac{b + a \phi(y)}{a + b \phi(y)} \right\} \frac{d y}{d z} = \mu(y) \frac{d y}{d z} \quad - \quad - \quad - \quad \text{(v)}$$

where

$$\phi(y) = \frac{\pi(y)}{F(y)} \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad (w)$$

and μ is a new functional symbol introduced for convenience.

VIII. Now

$$\frac{du}{dx} = \frac{du}{dy} \cdot \frac{dy}{dx} = \mu(y) \frac{du}{dy} \cdot \frac{dy}{dz} = \mu(y) \frac{du}{dz} \quad - \quad - \quad (x)$$

$$\frac{d^2u}{dx^2} = \frac{d}{dx}\left\{\mu(y)\frac{du}{dz}\right\} = \frac{d}{dz}\left\{\mu(y)\frac{du}{dx}\right\} = \frac{d}{dz}\left\{\left(\mu(y)\right)^2 \frac{du}{dz}\right\} \quad (y)$$

$$\frac{d^3u}{dx^3} = \frac{d}{dx} \cdot \frac{d}{dz}\left\{\left(\mu(y)\right)^2 \frac{du}{dz}\right\} = \frac{d^2}{dz^2}\left\{\left(\mu(y)\right)^3 \frac{du}{dz}\right\} \quad - \quad (z)$$

and so on. For we know that

$$\frac{d}{dx}\left\{V\frac{dv}{dz}\right\} = \frac{d}{dz}\left\{V\frac{dv}{dx}\right\}$$

where v is any function of the independent quantities x and z, and V any function of v.

IX. Next, denoting by a suffixed zero the value which a function takes when x vanishes (for instance, denoting by K_0 the value of K when $x = 0$) we have, by Maclaurin's theorem,

$$u = u_0 + \left(\frac{du}{dx}\right)_0 \cdot \frac{x}{1} + \left(\frac{d^2u}{dx^2}\right)_0 \cdot \frac{x^2}{1.2} + \&c. \quad - \quad (aa)$$

Hence, by what has preceded,

$$u = u_0 + \mu(y_0) \cdot \frac{du_0}{dz} \cdot \frac{x}{1} + \frac{d}{dz}\left\{\left(\mu(y_0)\right)^2 \cdot \frac{du_0}{dz}\right\} \cdot \frac{x^2}{1.2} +$$

a series whose general term is

$$\frac{d^{r-1}}{dz^{r-1}}\left\{\left(\mu(y_0)\right)^r \frac{du_0}{dz}\right\} \cdot \frac{x^r}{[r]^r} \quad - \quad - \quad (ab)$$

X. We have now to express u_0 or $f(y_0)$ as a function of z. For this purpose making $x = 0$ in (o) we deduce by means of (m), (n) and (o)

$$u_0 = f(y_0) = f\psi(w_0) = f\psi\{azF(y_0) + bz\pi(y_0) + \chi(y_0)\} \quad (ac)$$

whence

$$\psi^{-1}(y_0) - \chi(y_0) = z\left(aF(y_0) + b\pi(y_0)\right) \quad (ad)$$

or

$$\psi^{-1}(y_0) - \chi(y_0) = z\left(a + b\,\phi(y_0)\right) F(y_0) \qquad \text{- (ae)}$$

and the solution of this equation, when practicable, will give y_0 and u_0 or $f(y_0)$ as a function of z. Suppose, then, that from (ad) or (ae) we deduce

$$y_0 = \theta(z) \quad - \quad - \quad - \quad - \quad - \quad - \text{(af)}$$

then, after proper substitutions, (ab) becomes

$$f(y) = f\theta(z) + \frac{b + a\,\phi\theta(z)}{a + b\,\phi\theta(z)} \cdot \frac{d}{dz} f\theta(z) \cdot \frac{x}{1} +$$

$$\frac{d}{dz}\left\{\left(\frac{b + a\,\phi\theta(z)}{a + b\,\phi\theta(z)}\right)^2 \cdot \frac{df\theta z}{dz}\right\} \cdot \frac{x^2}{1.2} + \text{a series}$$

whose general term is

$$\frac{d^{r-1}}{dz^{r-1}}\left\{\left(\frac{b + a\,\phi\theta(z)}{a + b\,\phi\theta(z)}\right)^r \cdot \frac{df\theta z}{dz}\right\} \cdot \frac{x^r}{\lfloor r \rfloor^r} \quad - \quad \text{- (ag)}$$

XI. The process by which the expansion (ag) has been deduced resembles that by which the theorems of Laplace and Lagrange may be obtained. But the theorem here given is more general than either of those just mentioned, both of which may be derived from the theorem (ag). Thus, let

$$\left.\begin{aligned} &a = 1,\ b = 0,\ F(y) = 1,\ \pi(y) = \phi(y), \\ &\chi(y) = 0,\ \theta(z) = \psi(z) \end{aligned}\right\} \qquad \text{- (ah)}$$

then (ag) gives Laplace's theorem.

XII. In addition to the conditions (ah) let the condition

$$\psi(w) = w \quad - \quad - \quad - \quad - \quad - \quad - \quad - \text{(ai)}$$

be satisfied. Then (ag) is equivalent to Lagrange's theorem.*

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* This Paper was finished at Brisbane on April 10, 1866.—J. C.

Art. VII.—*The Rainfall in Victoria.* By R. L. J. Ellery, Esq., F.R.A.S., President of the Royal Society.

[Read 11th June, 1866.]

In bringing under your notice the records of the rainfall of Victoria, I intended to have referred to some of the causes which appear to govern its distribution, and to have appended a statement of the rainfall in other parts of Australia, but, unfortunately, all the requisite data have not come to hand, so that I shall have to leave this part of the subject for a future paper. It is also a matter of regret, that the records of rainfall in the colony itself are generally too incomplete, or extend over too short a period to render a fair annual average. The rainfall in Melbourne, however, forms an exception, as we possess records from the year 1840 to 1850, and from 1854 to the present date. This break in the series evidently occurred at the separation of this colony from New South Wales, for all the observations made from 1840 to 1850, were published in the New South Wales *Government Gazette.* Any observations, if obtained subsequent to that and prior to 1853 and 1854, cannot yet be found. This is the more unfortunate, for if that gap were filled up, any periodicity or secular diminution of the rainfall, should such exist, might have been traced.

The tables, although incomplete, present some interesting facts worthy of our attention; more especially as the late serious droughts, still existing in some parts, have given to the question of our rainfall a greater significance than, perhaps, it ever before assumed.

The rainfall in Victoria, and probably over the whole surface of Australia (except, perhaps, in the desert parts, if such exist), fully attains to the average of similar latitudes of other parts of the world, and would be adequate to the well-being of the country were it not for the enormous spontaneous evaporation. Of course there are causes which bring about large rainfalls in some localities, while others get none or little. We have whole districts which enjoy a greater humidity than usual, owing in some cases to heavier rainfall, and in many others to a lessened evaporation; but taking Victoria generally, the rainfall is rather above than below the average for similar latitudes.

If we assume the annual average rainfall in Melbourne to be 28·5 inches, which is not far from the truth, we

find it only reaches to about half the annual evaporation, which, according to Professor Neumayer's determinations and observations since made at the Observatory, amounts to about forty-five inches per annum. The largest amount of this evaporation, of course, takes place during our spring and summer months, with our strong dry winds; in winter the rainfall exceeds the evaporation by a considerable amount.

An opinion has often been expressed, that there is a kind of periodicity of seasons in Australia, that dry and wet years recur at intervals, which, if our observations extended back far enough, would be found to be in some degree regular. I think it within the bounds of possibility, that by a long and systematic record of the rainfall over the Australian continent, that some rough law would be deduced by which the recurrence of dry or wet years at stated intervals might be looked upon as probable. A glance over the diagram of rainfall in Melbourne for the last twenty-six years, does not, however, give us much foundation for such an hypothesis—the missing years come in at an awkward period—that is immediately after the abnormal rains of 1849—a few more years record subsequent to our heavy fall of 1863, are also required, when it would be seen if any similarity existed in the curves immediately following these very large deflections. Professor Newmayer, in a very interesting and valuable essay, in the Catalogue of the Victorian Exhibition, "On the Climatology of Victoria, states that the average rainfall from 1855 to 1860 differed but little from the average rainfall for any six consecutive years, from 1840 to 1848, excluding the abnormal rainfall of 1849;" but our rainfall of 36·43 inches in 1863, again thrusts up the curve high above the average, showing that that of 1849 was not a singular instance, and ought not to be excluded from the means.

An extended knowledge of our rainfall and evaporation I feel sure would teach us much that might be done to mitigate the disastrous consequences of so inadequate a rainfall as we have just suffered from. And above all, would point to the necessity of a large and general system of storage. The increased evaporation we are subject to indicates that the mere collecting the water in reservoirs is not the only consideration. The ratio of evaporation to the bulk increases with the surface—the reservoirs should rather be deep than of large surfaces. The greatest evaporation takes place during high, and especially high and dry winds—the

reservoirs should be in as sheltered positions as possible, and well planted on their margins. By increasing the number of water stores the amount of evaporation will be considerably lessened, in consequence of a greater humidity of the air. For the same reasons I think it injurious that our inland swamps should be drained, for although they may not, except to a very small extent, benefit the country beyond their immediate vicinity, they raise the dew point very appreciably, more especially at night, over a considerable area about them.

The Table B appended gives the total annual rainfall for Melbourne during twenty-five years, and for shorter periods in other localities in the colony where reliable observations have been made. A few years record of the rain in Adelaide and several localities in South Australia, is also added. The diagram shows graphically the rainfall for Melbourne for the period of twenty-five years, from 1840 to 1865. Table C contains the comparison of the rainfall of Melbourne with that at the Royal Observatory, Greenwich.

The desirability of securing a regular and systematic record of the rainfall over the whole of settled Australia, must be apparent to every practical or scientific man. Observations are required from every area of 500 square miles At present we have only ten localities in this colony where a regular register of the rainfall is kept.

No meteorological instrument is more simple in its construction and use than a rain-guage, and while there is any prospect of adding to our knowledge of Australian climatology, by its more extended use, it should be as common in the hands of our intelligent settlers as a barometer or thermometer.

TABLE B.

Years.	Melbourne.	Heathcote.	Ballaarat.	Portland.	Camperdown.	Beechworth.	Echuca.	Gabo Island.	Longerenong, Wimmera.	Ararat.	Sandhurst.	Cape Otway.	Adelaide.	Bungaree.	Kooringa.	Kapunda.	Mount Lofty.	O'Halloran Hill.	Mount Barker.	Strathalbyn.	Robe Town.	Mt. Gambier.	Penola.	Port Augusta.	Mount Remarkable.	Hamilton.	Aulaby.	Glenelg.
1840	22·57	...	...	...	...	...	...	...	...	...	...	...	20·15	...	9·75	...	32·00	...	32·00	22·42	23·17	55·69	38·61	...	...	...	...
1841	30·18	...	...	...	...	...	...	...	...	...	...	...	20·25	...	13·98	...	34·10	24·24	29·16	28·11	23·17	32·72	29·45	8·43	18·87	21·06	...
1842	31·16	...	...	...	...	...	...	...	...	...	...	...	14·46	...	17·17	20·20	15·69	30·16	22·45	15·75	23·17	32·72	40·95	8·26	22·77	19·54	...
1843	21·54	...	...	...	...	...	...	...	...	...	...	...	18·50	...	12·62	20·99	43·32	28·11	31·26	22·82	30·69	45·05	...	...	...	24·35	...
1844	28·26	...	...	...	...	...	...	...	...	...	...	...	24·03	26·70	21·85	24·99	56·84	29·86	...	...	...	...	...	...	...	20·89	...
1845	23·93	...	...	...	...	...	...	...	...	...	...	...	21·85	18·03	27·36	22·55	...	...	...	...	...	...	...	...	...	20·71	...
1846	30·63	...	...	...	...	...	...	...	...	...	...	...	23·67	27·36	...	24·99	...	...	...	...	...	...	...	...	...	...	...
1847	30·18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1848	33·15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1849	44·25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1850	26·98	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1851	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1852	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1853	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1854	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1855	28·21	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1856	29·75	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1857	28·90	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1858	26·02	23·79	24·47	27·30	27·97	30·87	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1859	21·80	21·86	23·72	31·42	27·60	...	15·76	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1860	25·40	29·01	28·80	26·31	29·97	...	19·13	32·82	17·26	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1861	29·15	28·78	28·66	39·58	36·94	29·70	...	38·74	20·17	23·35	18·50	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1862	22·98	16·99	23·56	31·01	26·15	26·94	...	49·12	33·08	37·37	33·92	49·66	23·67	27·36	22·55	24·99	56·84	29·86	31·26	22·82	30·69	45·05	40·95	8·26	22·77	24·35	20·71
1863	36·43	...	37·24	45·31	...	...	...	...	...	23·03	38·82	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1864	27·40	...	24·02	33·06	...	...	...	...	...	10·85	38·62	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1865	15·94	...	20·09	24·37	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

TABLE C.

Table showing the number of days of Rain and the amount of Rainfall for every month, and for each year, together with the average number of days of Rain, and average amount for every month for the period from 1858 *to* 1865.

FOR MELBOURNE.

Years.	January.		February.		March.		April.		May.		June.		July.		August.		Sept.		October.		Nov.		Dec.		For the whole Year.	
	Amount in inches.	No. of Days of Rain.	Amount in inches.	No. of Days of Rain.	Amount in inches.	No. of Days of Rain.	Amount in inches.	No. of Days of Rain.	Amount in inches.	No. of Days of Rain.	Amount in inches.	No. of Days of Rain.	Amount in inches.	No. of Days of Rain.	Amount in inches.	No. of Days of Rain.	Amount in inches.	No. of Days of Rain.	Amount in inches.	No. of Days of Rain.	Amount in inches.	No. of Days of Rain.	Amount in inches.	No. of Days of Rain.	Amount in inches.	No. of Days of Rain.
1858	0·88	9	4·91	12	1·09	9	0·60	11	1·38	15	0·76	13	2·07	18	1·61	16	2·17	22	0·87	10	3·19	11	6·47	12	26·02	158
1859	2·86	13	0·83	10	0·18	8	1·29	8	2·32	14	4·51	21	1·04	13	0·95	17	2·77	16	2·33	13	1·71	12	1·02	11	21·82	156
1860	1·97	10	1·07	4	0·96	6	4·52	12	0·99	11	1·72	16	1·21	9	0·79	10	2·72	17	1·97	15	2·38	12	5·06	11	25·38	133
1861	2·25	14	4·62	13	2·65	9	1·29	11	0·84	12	1·78	16	2·14	16	1·47	14	3·19	17	4·89	14	1·46	11	2·58	12	29·15	159
1862	1·25	4	0·19	3	1·08	8	3·56	14	4·31	19	2·99	16	2·26	20	1·95	14	0·98	14	2·03	11	0·32	9	1·16	7	22·08	139
1863	1·84	9	2·74	12	3·84	14	1·76	10	2·54	16	1·16	10	2·87	16	2·10	18	1·99	15	4·89	18	3·51	13	7·18	14	36·43	165
1864	2·07	7	2·63	9	1·80	7	4·53	18	1·02	9	0·81	10	2·83	13	2·50	18	2·28	14	4·08	18	0·64	9	2·21	12	27·40	144
1865	0·16	3	0·59	8	1·26	8	0·72	7	3·41	18	1·64	10	2·05	14	1·22	14	1·87	13	0·78	8	0·89	7	1·35	9	15·94	119
	1·66	8·6	2·20	8·9	1·61	8·6	2·28	11.4	2·10	14·2	1·92	14·0	2·06	14·9	1·57	15·1	2·25	16·0	2·73	13·4	1·76	10·5	3·38	11·0	25·53	147
	FOR GREENWICH (ENGLAND) DURING THE PERIOD FROM 1858 TO 1862.																									
1858	0·76	5	1·72	6	0·82	8	2·34	11	1·99	17	1·24	5	2·97	12	1·53	8	0·88	10	1·36	9	0·45	7	1·67	14	17·8	112
1859	0·80	11	0·86	12	1·35	10	2·17	13	2·35	9	1·43	7	3·26	7	1·13	11	3·80	17	3·60	18	2·90	13	2·17	17	25·9	145
1860	1·81	21	1·10	13	1·85	18	1·00	13	3·90	14	5·80	23	2·80	10	3·68	25	3·10	17	1·60	10	2·50	11	2·75	16	32·0	191
1861	0·55	7	0·78	11	2·21	21	0·83	6	1·83	8	1·90	15	2·18	20	0·59	9	1·49	15	0·89	10	5·06	15	1·25	10	20·4	147
1862	1·79	17	0·46	6	3·55	21	2·84	13	2·84	16	1·93	17	1·69	12	3·01	11	1·61	12	4·08	17	1·02	10	1·63	17	26·3	169
	1·14	12·2	1·18	9·6	1·96	15.6	1·84	11·2	2·58	12·8	2·46	13·4	2·58	12·2	1·99	12·8	2·18	14·2	2·31	12·8	2·39	11·2	1·89	14·8	24·48	153

PROCEEDINGS.

PROCEEDINGS.

ROYAL SOCIETY OF VICTORIA.

Session 1866.

MINUTES OF PROCEEDINGS.

15th *January*, 1866.

GENERAL MEETING.

The President, the Rev. J. J. Bleasdale, D.D., in the chair.

The following contributions were announced :—"Alga," classified and described by Jacob G. Agardh. "Alga," by the same author, 1848, 1851 ; 2 parts, 1851, 1852, and 1860. "Theoria Systematis Olantamae," 1858 ; and "Reculio Specierum Generis Pterides, 1839, by Jacob G. Agardh. "On Mineralogie," by Franz Von Robell. "Tafelu Zur Bestimung der Mineralien," by Franz Von Robell. "Lychnophora," by Dr. Von Martins. "Patent Gunpowder," by Pedro Nisser, M.E. "Fragmenta Phytographiæ Australiæ," No. 35, by Dr. F. Mueller.

The President read a letter from Professor Nevill S. Maskelyn, British Museum, London, on the Gem Exhibition held in May last, and also intimated that the Council for conducting the Inter-Colonial Exhibition, 1866, was desirous of obtaining assistance upon all matters relative to gems and minerals of the colony.

It was resolved—"That the suggestions of the President as to the "co-operation of the Royal Society be referred to the Council for "its consideration."

The meeting then proceeded to the Election of Officers, and the following gentlemen were declared elected :—

President :

R. L. J. Ellery, Esq.

Vice-Presidents :

C. W. Ligar, Esq. A. K. Smith, Esq.

Treasurer :

J. B. Were, Esq.

Librarian and Custos of Collection :
Thos. Harrison, Esq.

Secretary :
Thos. H. Rawlings, Esq.

Council :

T. E. Rawlinson, Esq.	Rev. J. J. Bleasdale, D.D.
C. D'O. H. Aplin, Esq.	Dr. F. Mueller.
G. S. Lang, Esq.	Professor Halford.

It being determined that the vacancy in the Council, caused by the election of Mr. Rawlings to the office of Hon. Secretary, be now filled up, a ballot was taken, and Robert Adams, Esq., declared duly elected.

(Signed) Robt. L. J. Ellery.

12th February, 1866.

12*th February*, 1856.

Ordinary Meeting.

The President, R. L. J. Ellery, Esq., in the chair.

The President announced that the Council, in accordance with a resolution of the members, had determined—"On holding an Exhi-"bition of Gems and Precious Stones, prior to the Inter-Colonial "Exhibition. The Gems so exhibited to be afterwards placed in the "Inter-Colonial Exhibition."

The following contributions were announced :—"Transactions Royal Society, Mauritius," Parts 1 and 2. "Reports and Proceedings of the Liverpool Institute, 1861 to 1863," 4 vols. "Lectures on Common Truths." "Reports of Queen's College, and School of Arts, Liverpool," 3 vols. Vols. IV. and V. "Transactions Royal Society of Upsal :" "Die Entwicklung Der Menschen und des un ere"—Dr. Erdes. Parts 3 4, and 6, "Royal Geographical Society, London." Part 36, "Fragmenta Phytographæ Australiæ,"—by Dr. Mueller.

The Hon. Secretary also read a letter from the Right Hon. E. Cardwell, Colonial Secretary, announcing that Her Majesty had been pleased to accept Vol. VI. of the "Transactions of the Royal Society of Victoria," and conveying the thanks of Her Majesty for the copy forwarded.

The President read a paper "On Ozone, and its influence upon the human frame."

A discussion ensued, in which Mr. Bonwick, Mr. Gilbee, Professor Halford, and Dr. Mueller took part.

The President afterwards replied to several questions put as to the results of his observations, and promised a further communication.

Mr. Rawlinson exhibited a wire-worm found in a drain in Reilly-street, of a species seldom met with.

(Signed) ROBT. L. J. ELLERY.

12th March, 1865.

12th March, 1866.

ORDINARY MEETING.

The President, R. L. J. Ellery, Esq., in the chair.

The Council forwarded a message recommending that the names of thirteen gentlemen be removed from the List of Members, for non-payment of subscription.

Upon the motion of Mr. Rawlinson, seconded by Mr. James Osborne, the recommendation was adopted.

Mr. A. S. Wilkins, and Mr. G. W. Groves, were proposed and seconded as candidates for Ordinary Membership. The ballot to take place at the next meeting.

The following contributions were announced:—Parts 1 to 5, "Ethnological Journal." Parts 1 to 4, Vol. I., and Parts 1, 2, and 4, Vol. II. "Transactions Academy, Munich." "Induction and Deduction," by Professor Von Leibeg. "On Natural History of Art," by Dr. C. Nageli." Mr. C. W. Ligar laid upon the table various specimens of varnish, picric acid, gum, sugar, and spirit, obtained from the Grass Tree (Xanthorea).

Mr. C. W. Ligar read a paper "On the Grass Tree and its productions."

An interesting conversation arose afterwards, in which most of the members present took part; the peculiarly practical character of the paper giving it an interest of an uncommon kind; the specimens laid on the table exhibiting so markedly the richness of the Grass Tree in saccharine matter.

Mr. Bonwick read a paper "On the Volcanic Rocks of Rome and Victoria compared," exhibiting several specimens of stone, clay, tufa, &c., brought from the Catacombs of Rome and its neighbourhood.

The Rev. Dr. Bleasdale read a paper "On a Green Sapphire—the Oriental Emerald—found in North-east Gipps Land.

(Signed) ROBT. L. J. ELLERY.

9th April, 1865.

9th April, 1866.

ORDINARY MEETING.

The President, R. L. J. Ellery, in the chair.

The following contributions were announced :—"Fragmenta-Phytographæ Australiæ," No. 37—by Dr. Mueller. 1 part "Statistical Society of London." 1 part "Royal Geographical Society of London."

The gentlemen nominated at the last meeting were balloted for and declared duly elected.

Professor Halford read a paper, "Notes on an Experimental Inquiry into the Absorption of Colouring Matter into the Blood."

Dr. Ralph, Mr. Ellery, and the Rev. Dr. Bleasdale, spoke generally in confirmation of Professor Halford's paper.

(Signed) ROBT. L. J. ELLERY,

11th June, 1865.

14th May, 1866.

ORDINARY MEETING.

There being no quorum at five o'clock, the meeting stood adjourned.

THOS. H. RAWLINGS, Hon. Secretary.

(Signed) ROBT. L. J. ELLERY.

11th June, 1865.

11th June, 1866.

ORDINARY MEETING.

The President, R. L. J. Ellery, Esq., in the chair.

The President announced, that through the departure of Sir Charles H. Darling, and the general unsettled state of Ministerial matters, it had been deemed better not to hold the dinner referred to at a former meeting, the presence of the Governor and the Ministers being a standing point with the Society, and in place thereof it was now proposed to hold a *conversazione*, at which the address of the President would be read, and to which members and their friends would be invited.*

The following contributions were announced :—"Catalogue Free Library Manchester," 16 quarterly parts, 1861 to 1865. "Statisti-

* This *conversazione* was held on the 2nd July, and the address of the President read.

cal Society of London," 5 vols., 1860 to 1864. "Institution of Naval Architects, London," Vol. I., Part 1. "Royal Geological Society, London," Parts 1, 2, 3, 4, Vol. V. and Parts 1, 2, 3, 4, Vol. VI. "Tjdschrift Voon Nijverheid en Lanbrowr in Nederlandsch, India." No. 1, 1865, "Jahrbuch der Kauirlich, Konïglichen Geologischen Reichsantalt." "Nachrixhten Vonder K. Gesellschaft Wissenchaften und der—Georg August, Universtat Gottingen." No. 1, Feb. 1865, "Royal Horticultural Society.

A vacancy in the Council was declared, by the resignation of Dr. Mueller, and Mr. Eugene Von Guerard was nominated and elected.

Mr. Cosmo Newberry, Analyst, Geological Survey, was nominated as an Ordinary Member. The ballot to be taken next meeting.

Sir Redmond Barry, on the part of Chief Justice Cockle, of Queensland, handed in a paper "On Differential Equations and Coresolvents." The paper was not of that character that could be read, but by its publication, priority of discovery on a very important branch of science would be obtained. Sir Redmond Barry stated that Mr. Cockle ranked with Boole, Rawson, Cayley, and other algebraic authorities ; had taken high mathematical honours at Cambridge, and now employed his leisure moments in abstruse calculations of the character of the paper now presented. The theory propounded was a novel one, and strange to say, like the discovery by Adams and La Verrier of the planet Neptune, Mr. Justice Cockle had received a letter from Mr. Harley, crossing one, sent home with a similar discovery, the results of which were almost the same. Sir Redmond Barry trusted the Royal Society would see the necessity of immediately publishing so important a paper, which must benefit the Society as well as confer a benefit on science.

The President then read a paper "On Rain-fall in Victoria."

Mr. A. K. Smith made a few remarks as to the great utility a knowledge of the rain-fall would have upon the construction of various engineering works, instancing cases that had come under his own immediate notice, and stating that a large amount of money was wasted from a want of adherence to laws which had been so clearly made manifest by the paper just read.

(Signed) Robt. L. J. Ellery.

9th July, 1866.

ROYAL SOCIETY.

Dr. *Balance-Sheet*, 1863, *per Contra.* *Cr.*

1862.		£ s. d.	£ s. d.
Dec. 1.	To Balance, per audited Balance-sheet	25 18 5	
	Less Balance lapsed of the Vote of 1861 for printing Transactions	1 17 0	
1863.			24 1 5
Jan. 9 to Nov. 30.	To Cash, viz.—		
	90 Subscriptions, at £2 2s. ...	189 0 0	
	13 ,, at £1 1s. ...	13 13 0	
	8 Entrance Fees, at £2 2s. ...	16 16 0	
	3 Life Subscriptions, £10 10s.	31 10 0	
	Sundries	0 3 6	
			251 2 6
	Publishing Fund		86 2 0
			£361 5 11
1863.			
Nov. 30.	Balance brought down—		
	General Account	6 8 10	
	Publishing Fund	86 2 0	
			£92 10 10

1862.		£ s. d.	£ s. d.
Dec. 1 to 1863. Nov. 30.	By Expenditure, viz.:—		
	Clerical Assistance	80 0 0	
	Treasurer's Petty Cash ...	10 0 0	
	General Printing & Stationery	38 18 0	
	Postages	25 4 11	
	Incidentals	72 11 2	
	Printing and Binding Transactions	42 1 0	
			268 15 1
	Balance General Account... ...	6 8 10	
	Publishing Fund	86 2 0	
			92 10 10
			£361 5 11

(Signed) H. F. EATON.

Nov. 30, 1863. *Hon. Treasurer.*

We hereby certify that we have examined the above Balance-sheet, have compared the entries with the vouchers, and find the same correct.

(Signed) JAS. S. BUTTERS.

(Signed) A. KENNEDY SMITH.

NOTE, JULY, 1866.—This Balance-sheet should have been appended to the Annual Report for 1863, and printed page xiv of Vol. VI. The error arose through the omission of a copy in the Minute Book, and is not chargeable to the Treasurer, Mr. H. F. EATON.

MEMBERS

OF

The Royal Society of Victoria.

*Those whose names have * or † prefixed, are Life or Honorary Members respectively.*

Adams, Robert, Esq., C.E., Prospect House, St. Kilda.
Archer, W. H., Esq., Registrar-General of Victoria.
Aplin, C. D'O. H., Esq., Temple-court, Melbourne.

†Barkly, Sir Henry, K.C.B., His Excellency.
*Barry, Sir Redmond, Chancellor of the University.
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Christopherson, O. H., Esq., Mines Office.
Chirnside, Thomas, Esq., Melbourne Club.
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Higinbotham, Hon. George, M.L.A., Attorney-General.
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Manton, C. A., Esq., Treasury.
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McGowan, S. W., Esq., Sup. Electric Telegraph Department.
McGillivray, P. H., Esq., Hospital, Sandhurst.
†Martins, Dr. Von, Academy of Science, Munich.

†Neumayer, George, Professor, Bavaria.
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Napier, James, Esq., Commercial Bank of Melbourne.
Newberry, Cosmo, Esq., Geological Analyst.

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Wild, Edward, Esq., Collingwood.
Woods, Rev. Julian E. T., South Australia.
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Walker, William, Esq., St. Kilda.
Wilkinson, Charles, Esq., Geological Survey Office.

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